A COMPARATIVE STUDY TO EVALUATE VASODILATORY EFFECT OF DESFLURANE VS SEVOFLURANE USING PERFUSION INDEX

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Dedicated

to

my Parents

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-Dr Gunjan

LIST OF ABBREVIATIONS

ASA	American Society of Anesthesiologists
CPB	Cardiopulmonary bypass
CVS	Cardiovascular system
DBP	Diastolic blood pressure
HR	Heart Rate
HRV	Heart rate variability
IMR	Index of Microcirculatory Resistance
IVC	Inferior vena cava
MAC	Minimum alveolar concentration
MAP	Mean arterial pressure
NIBP	Non-invasive blood pressure
PI	Perfusion Index
PVI	Plethysmographic variability index
SAB	Subarachnoid Block
SBP	Systolic blood pressure
SVR	Systemic vascular resistance
VAS	Visual analog scale

ABSTRACT

Introduction: Sevoflurane and Desflurane are the most commonly used inhalational anesthetics. Due to their rapid induction and recovery times, they are advantageous for short and outpatient procedures. However, these volatile anesthetics cause dose-dependent effects on cardiovascular function, either through effects on the myocardium itself or by decreasing systemic vascular resistance (SVR) and sympathetic outflow. Understanding these differing effects of inhaled anesthetics on hemodynamics and perfusion can help guide anesthetic choices based on patient-specific needs. Perfusion index (PI) can effectively assess peripheral perfusion dynamics and vascular tone. It can be non-invasively and continuously obtained using a pulse oximeter. With this background, the present study has been designed to compare the vasodilatory properties of Desflurane and Sevoflurane.

Aims and Objectives:

- To compare vasodilatory properties of Desflurane and Sevoflurane using perfusion index.
- To compare Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure.

Material and Methods: A prospective randomized study was conducted on 60 adult patients posted for surgery under general anesthesia and divided into two equal groups. Sevoflurane or Desflurane was used to maintain anesthesia as per group allocation. After the induction of anesthesia, all parameters, including PI, HR, SBP, DBP, and MAP, were continuously recorded every minute for 20 minutes at 1.0 MAC and compared between both groups.

Results: In patients who received Desflurane, the PI values remained significantly higher compared to those who received Sevoflurane (mean difference: 2.44; $P<0.001$). The heart rate also remained higher in the Desflurane group compared to the Sevoflurane group mean difference: (5.69 bpm; p-value 0.011). The Desflurane group had significantly lower SBP values (100.56 vs. 113.14 mm Hg; mean difference: 12.58 mm Hg; $P<0.001$) and lower DBP values (64.64 vs. 71.18 mm Hg; mean difference: 6.54 mm Hg; $P<0.046$) compared to the Sevoflurane group. Additionally, MAP values were consistently lower in the Desflurane group compared to the Sevoflurane group (76.62 vs. 85.16 mm Hg; mean difference: 8.54 mm Hg; $P<0.001$).

CONCLUSION: Therefore, we conclude that Desflurane resulted in higher PI and HR values, with lower SBP, DBP, and MAP, compared to Sevoflurane. The study suggests that Desflurane has a greater vasodilating effect, which may have led to improved perfusion.

Keywords: Perfusion Index, Desflurane, Sevoflurane, Inhalational anesthetics, Cardiovascular function, Vasodilation, Systemic vascular resistance.

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INTRODUCTION

Inhalational anesthetic agents play a vital role in the initiation and maintenance of general anesthesia, ensuring smooth induction, optimal surgical conditions, and swift recovery with minimal side effects. Desflurane and Sevoflurane, two commonly employed volatile anesthetic agents, are pivotal in contemporary anesthesia practice[1,2]. Known for their quick onset and recovery properties, these anesthetic agents offer clear advantages in ensuring smooth anesthesia induction and rapid post-operative recovery[3,4]. This is due to their unique pharmacokinetic profiles, including low blood-gas partition coefficients, making them the preferred choice for a variety of surgical procedures. Low blood-gas partition coefficients enable rapid induction, precise control of end-tidal concentration during maintenance, swift recovery, and reduce incidence of post-anesthesia airway complications.

Inhalational anesthetic agents significantly affect the cardiovascular system (CVS), so it's important to consider these effects when managing anesthesia. These agents have a dose-dependent impact on cardiovascular function, directly affecting the heart and reducing systemic vascular resistance (SVR) and sympathetic outflow[5].

Desflurane is a clear, nonflammable liquid with a distinct odor. It is an ether inhalational general anesthetic agent known for its role in modern anesthesia practice[5]. Its lower anesthetic potency translates to higher minimum alveolar concentration (MAC) values than other agents. Desflurane's cardiovascular effects are notable for its direct action on the CVS, inducing a dose-dependent reduction in myocardial contractility, cardiac output, and blood pressure. Additionally, it prompts vasodilation, particularly in peripheral arterioles, leading to significant reductions in SVR and arterial blood pressure. This mechanism primarily involves direct interaction with vascular smooth muscle cells, causing relaxation and subsequent widening of blood vessels. Also, Desflurane is known to cause a temporary increase in HR and BP when the inspired concentration is

rapidly increased, possibly due to sympathetic stimulation[6]. This effect is especially noticeable during anesthesia induction and may not be suitable for patients at risk of cardiovascular instability.

Sevoflurane, another pivotal volatile inhalational anesthetic, distinguishes itself with its rapid onset and offset of action, making it a cornerstone of modern anesthesia. While sharing similarities with Desflurane, Sevoflurane exhibits nuanced differences. Unlike Desflurane, Sevoflurane does not cause tachycardia at higher MAC values. Although Sevoflurane reduces BP like other volatile anesthetics, this decrease is lower than that caused by Desflurane at higher concentrations. Moreover, Sevoflurane, similar to equi-anesthetic concentrations of Isoflurane and Desflurane, decreases myocardial contractility without enhancing epinephrine-induced cardiac arrhythmias. Regional blood flows, such as hepatic, renal, and cerebral circulation, are affected similarly by Sevoflurane as by Desflurane. Additionally, Sevoflurane reduces baroreflex function comparably to other volatile anesthetics[2].

Sevoflurane decreases left ventricular afterload by modifying the mechanical properties of the aorta, while Desflurane mainly reduces SVR by dilating arteriolar resistance vessels, contributing significantly to its characteristic decrease in SVR[7]. These distinctions in their cardiovascular effects contribute to variations in their impact on hemodynamic and cardiovascular parameters, potentially leading to divergent outcomes in terms of morbidity and mortality. Thus, while both Desflurane and Sevoflurane are vital components of modern anesthesia, understanding their unique cardiovascular effects is crucial for optimizing patient care and outcomes.

Hemodynamic depression, including hypotension, is a common occurrence during general anesthesia, potentially leading to organ hypoperfusion, ischemia, and various complications[8,9]. Ensuring stable intraoperative hemodynamics can reduce adverse outcomes and thus promote early recovery, thus shortening hospital stays. Patients with physiological frailty

and underlying health conditions are at a greater risk of hypotension, which occurs more frequently after anesthesia induction. Ageing results in certain physiological changes, such as vascular and myocardial stiffening, as well as increased sympathetic activity, making them more vulnerable to hemodynamic instability[10]. Additionally, elderly individuals often experience multiple health issues and take various medications, which can affect their cardiovascular health. While compensatory tachycardia aids in maintaining cardiac output in young, healthy adults, this mechanism diminishes with age. Tachycardia in the elderly can exacerbate the reduction in cardiac output by depressing contractility, leading to a more significant decline as compared to younger patients.

Monitoring perioperative hemodynamic parameters is crucial for diagnosing and treating hypotension, preventing organ damage, and tailoring care, especially for high-risk patients like those with hypertension. Predicting severe hypotension in patients helps anesthesiologists prepare and adjust treatments [11]. Anesthetic agents affect hemodynamics, but their impact is complex due to natural circulatory reflexes and substances released in response. To thoroughly understand these effects, it is vital to record multiple dependent variables. The standard method of monitoring intraoperative hemodynamics, like noninvasive blood pressure(NIBP), is intermittent and may not promptly detect hypotensive episodes[12]. Vascular tone is crucial for understanding organ perfusion and carrying out hemodynamic assessments. Additionally, NIBP does not provide beat-to-beat variation in hemodynamics. As organ perfusion relies on more than just blood pressure, it is important to consider factors such as vascular tone and regional perfusion[13]. Various methods, such as baseline heart rate variability (HRV), inferior vena cava (IVC) collapsibility, and plethysmographic variability index (PVI), have been explored as predictors of hypotension. Invasive methods to assess perfusion in clinical settings primarily involve techniques that can directly measure blood flow and vascular resistance within specific tissues or organs. One such method

involves using techniques such as the Index of Microcirculatory Resistance (IMR) and dynamic computed tomography (CT) perfusion imaging. These techniques are particularly valuable in settings where precise assessment of tissue perfusion is necessary to guide therapeutic decisions. The non-invasive technique of monitoring the Perfusion Index (PI) through plethysmography allows for continuous, real-time evaluation of peripheral perfusion. This approach plays a critical role in the early detection of hemodynamic instability and changes in peripheral perfusion [14]. This non-invasive method serves as a substitute for measuring vasoconstriction and vasodilation caused by vasoactive drugs, including volatile anesthetics. The pulse oximeter evaluates peripheral oxygen saturation and HR through plethysmography technology. The PI indicates the ratio between pulsatile and non-pulsatile blood flow in peripheral tissues. The principle of SpO2 is based on two light sources with different wavelengths, 660 nm and 940 nm, transmitted through the cutaneous vascular bed of the finger or earlobe. The absorbance of both wavelengths includes a pulsatile component, which indicates variations in the volume of arterial blood between the source and the detector. The non-pulsatile component arises from connective tissue, bone, and the venous compartment[15,16].

This method is less likely to cause infection, thrombosis, or other complications associated with the invasive techniques. Furthermore, noninvasive PI monitoring is simpler and quicker to implement, which can be advantageous in emergency settings or during rapid patient deterioration, where time and patient stability are critical factors. It allows for a more dynamic assessment of the effectiveness of therapeutic interventions and can be used in various clinical settings without the need for extensive setup or specialized training. Overall, the use of non-invasive PI monitoring can improve patient safety, reduce complications, and provide critical information for timely and appropriate clinical decision-making in critically ill patients.

PI values are affected by blood flow in peripheral circulation and vascular tone, reflecting a balance between the sympathetic and parasympathetic nervous systems. Decreased vascular tone results in a higher PI[17]. Various intraoperative factors, such as systemic hemodynamics, including mean arterial pressure (MAP) and cardiac output, can influence PI. Hematocrit levels can also influence PI, as lower hematocrit during cardiopulmonary bypass (CPB) correlates with reduced microvascular perfusion. Additionally, patients with lower baseline PI values are at greater risk of developing intraoperative hypothermia; conversely, hypothermia can lead to reduced perfusion[18]. PI can measure peripheral perfusion dynamics in response to changes in peripheral vascular tone. Reduction in vascular tone can cause blood to pool in the periphery, leading to a higher PI. On the other hand, it decreases in instances of sympathetic predominance or low cardiac output states, thereby serving as a valuable predictor of patient outcomes in critical care settings[14].

Utilizing PI as a surrogate for cardiac output can significantly aid in evaluating fluid responsiveness. Additionally, it can provide an invaluable, objective measure of pain, particularly in uncooperative patients, and accurately predict successful weaning from mechanical ventilation. Its simplicity in measurement, ease of interpretation, and continuous display make it a convenient parameter for assessing blood flow adequacy and sympathetic-parasympathetic balance[14].

Both general and regional anesthesia can influence PI through their effects on vascular tone and blood flow. Spinal anesthesia generally increases PI due to decreased resistance, and general anesthesia affects PI based on the specific pharmacodynamics of the anesthetic agents used.

Various studies have previously employed PI to assess hemodynamic parameters. A study conducted by Duggappa DR et al. demonstrated that PI is an effective tool for predicting hypotension in healthy parturients undergoing elective cesarean section under subarachnoid block (SAB). Parturients with a baseline PI greater than 3.5 were at a higher risk of

developing hypotension following SAB compared to those with a baseline PI of 3.5 or less[19].

Sripada G. Mehandale conducted a study that utilized PI as an indicator for hypotension following induction with propofol. They concluded that PI could effectively predict the occurrence of hypotension following the administration of propofol[20].

Most volatile anesthetic agents lead to concentration-dependent decreases in myocardial contractility and SVR, resulting in arterial pressure reductions. While older agents like halothane and enflurane primarily reduce arterial pressure by decreasing myocardial contractility, newer agents like Desflurane and Sevoflurane primarily decrease SVR.

Ryu et al. conducted a study comparing the vasodilatory properties of Desflurane and Sevoflurane using PI. Their findings revealed a positive correlation between PI and vasodilation. At an equi-anesthetic concentration of 1.0 MAC, Desflurane was observed to be associated with higher PI values compared to Sevoflurane, but significantly lower MAP. The authors suggested that Desflurane has greater vasodilating effects than Sevoflurane at equipotent anesthetic concentrations[21].

These findings indicate that PI is a valuable tool in clinical practice for assessing the vasodilatory effects of inhaled anesthetics, which is crucial for customizing anesthesia management to individual patient needs. Monitoring PI intraoperatively can provide real-time insight into the effects of these anesthetics on peripheral perfusion, allowing for adjustments in anesthesia depth and management of potential hemodynamic instability. However, there is limited data to assess vasodilation caused by inhalational agents using PI as a marker. Thus, this study was designed to use PI to compare the vasodilatory properties of Desflurane versus Sevoflurane in patients undergoing elective surgery under general anesthesia.

AIMS AND OBJECTIVES

To compare vasodilatory properties of Sevoflurane vs Desflurane by evaluating:

1. Perfusion Index (PI)
2. Heart Rate (HR)
3. Systolic blood pressure (SBP)
4. Diastolic blood pressure (DBP)
5. Mean arterial pressure (MAP)

REVIEW OF LITERATURE

Inhalational anesthetic agents play a crucial role in initiating and sustaining general anesthesia. Sevoflurane and Desflurane are commonly used as general anesthetics due to their rapid pharmacokinetic profiles. Their lower solubility provides more precise control over delivery and a faster recovery from anesthesia.

All volatile anesthetics cause dose-dependent decreases in SVR and myocardial contractility, ultimately leading to reductions in arterial pressure. Previous research in chronically instrumented animals has demonstrated that Desflurane and Sevoflurane induce similar, dose-dependent reductions in myocardial contractility[7,22,23].

The administration of volatile anesthetics can lead to vasodilatory responses, which in turn can enhance microvascular perfusion. This improved peripheral perfusion is linked to an increase in tissue oxygen tension, potentially aiding in the reduction of tissue infection and promoting more effective wound repair. Conversely, volatile anesthetics with more potent vasodilatory properties may cause hypotension, leading to adverse perioperative outcomes[8].

DESFLURANE

Desflurane is a halogenated ether used as a volatile anesthetic agent. It was developed as a modification of Isoflurane, substituting a fluorine atom for chlorine, significantly altering its pharmacokinetic properties[24]. Desflurane has a low blood-gas partition coefficient of 0.42, allowing for rapid induction and emergence from anesthesia. This characteristic makes it particularly useful in outpatient and ambulatory surgical settings where quick recovery is advantageous[25].

Desflurane is known for its rapid onset and offset of action, allowing for precise control over anesthetic depth and quick postoperative recovery. However, its pungent odor and potential to irritate the respiratory tract limit its use for inhalational induction, particularly in pediatric patients[26]. It is

primarily used to maintain anesthesia after induction with intravenous agents.

Desflurane's hemodynamic profile closely resembles that of Isoflurane, leading to dose-dependent decreases in BP and minimal myocardial depression. However, it can induce sympathetic nervous system activation, which may pose problems in patients with cardiovascular diseases[26].

Economically, the rapid recovery profile of Desflurane can potentially reduce operating room turnover times and overall costs. However, its higher cost than other agents like Sevoflurane may offset these benefits.[27]

SEVOFLURANE

Sevoflurane, a halogenated ether, was first synthesized in the late 1960s and was approved for clinical use in Japan in 1990, followed by approval in the United States in 1995. It is widely used for inducing and maintaining general anesthesia in adult and pediatric patients due to its favorable pharmacokinetic properties, including a low blood-gas partition coefficient of 0.69, allowing for rapid induction and emergence from anesthesia. Sevoflurane is particularly beneficial for pediatric anesthesia due to its non-pungent odor and minimal respiratory irritant effects, allowing mask induction[28].

It is metabolized in the liver, which produces inorganic fluoride and a breakdown product known as compound A, raising concerns about potential nephrotoxicity. However, clinical studies have not conclusively demonstrated significant renal injury in humans under typical clinical conditions [29].

The drug is generally well-tolerated, with MAC of 2.05%. It is used in concentrations of 0.5-3% for surgical anesthesia, often in combination with nitrous oxide. Sevoflurane has been shown to offer a rapid recovery profile, which is advantageous in ambulatory settings[30].

Despite its widespread use, there are ongoing concerns about potential neurotoxic effects, particularly in pediatric and elderly populations. This necessitates careful consideration of the dosage and duration of exposure.

The FDA recommends using fresh gas flow rates of at least 1 L/min for exposures up to 1 hour and at least 2 L/min for longer exposures to minimize potential risks[29].

HEMODYNAMIC EFFECTS OF DESFLURANE AND SEVOFLURANE

Desflurane and Sevoflurane have different hemodynamic profiles, which have been assessed in various studies. A study by Lowe et al. demonstrated that low SVR resulting from Desflurane is mainly due to the dilation of arteriolar resistance vessels. On the other hand, decreases in left ventricular afterload induced by Sevoflurane may occur primarily through alterations in the mechanical properties of the aorta[22].

Another study by Rodig et al. was conducted on 52 patients using Cardiopulmonary bypass (CPB) to exclude the cardiac effects of inhalational agents. This allowed the researchers to study the effect on systemic vasculature solely. The study concluded that vasodilation might be attributed to the direct relaxing actions on the vascular smooth muscle, reduction in sympathetic output, or reduction in the effectiveness of other stimuli on the vascular smooth muscle[31].

In their study, Muzi et al. investigated how different concentrations and rates of change of Desflurane affect sympathetic and hemodynamic responses in 23 healthy male volunteers. They found that there was no consistent threshold concentration of Desflurane that consistently triggered these responses, suggesting that individuals have varying sensitivity to the effects of Desflurane. The volunteers were initially anesthetized with propofol and vecuronium and then exposed to different rates of increase in Desflurane concentration until reaching 1.5 MAC. The results showed that while the HR increase was not dependent on the rate or concentration of Desflurane, the sympathetic nerve activity responses were directly proportional to the rate of change in Desflurane concentration. Rapidly increased inspired Desflurane concentration led to sympathetic activation, characterized by tachycardia and hypertension[32].

A study conducted by Bedforth et al; compared the cerebral and systemic hemodynamic responses of twenty healthy adult patients scheduled for non-neurological surgery. After the induction of anesthesia with propofol, either Desflurane or Sevoflurane (n = 10 per group) was introduced. Desflurane at 7.2% or Sevoflurane at 2.2%, respectively, and increased to 10.8% or 3.3%, respectively, 2 minutes later. The study concluded that patients receiving Desflurane had significantly higher middle cerebral artery blood flow velocities, HR, and blood pressures than those receiving Sevoflurane ($P < 0.01$)[33].

A study by Lee et al. compared the hemodynamic effects of Desflurane and Sevoflurane during anesthesia induction and intubation in adult patients undergoing spine surgery. The study involved 400 patients, with half receiving Desflurane and the other half receiving Sevoflurane. The results showed that Desflurane led to a higher HR than Sevoflurane, especially in younger patients. The study concluded that Desflurane may induce a higher HR, and careful monitoring is essential[34].

MONITORING HEMODYNAMIC CHANGES

Monitoring preoperative hemodynamic parameters is crucial for diagnosing and treating hypotension, preventing organ damage, and tailoring care, especially for high-risk patients like those with hypertension. The standard methods of monitoring intraoperative hemodynamics, NIBP, is intermittent and may not promptly detect hypotensive episodes. Vascular tone is an essential factor for understanding organ perfusion and hemodynamic assessments

PERFUSION INDEX (PI)

The pulse oximeter is an indispensable device in medical practice, playing a pivotal role in assessing peripheral oxygen saturation and HR using advanced plethysmography technology. Pulse oximetry-derived perfusion index (PI) is another variable that is measured by pulse oximeters. The PI is the ratio of the pulsatile component (arterial) and non-pulsatile component

of light reaching the detector. The non-pulsatile component is from connective tissue, bone, and venous compartment[14].

The values of PI are influenced by both the blood flow in the peripheral circulation and the vascular tone, reflecting the complex interplay between cardiac output and the balance of the sympathetic and parasympathetic nervous systems. PI indicates the status of microcirculation, which is densely innervated by sympathetic nerves and is influenced by multiple factors responsible for either vasoconstriction or vasodilatation. It is also purported to indicate SVR[15].

ROLE OF PERFUSION INDEX

In a study published by Elshal et al., it was concluded that PI is an irreplaceable vital sign with many important uses, such as a prognostic marker in critically ill and surgical patients, guiding fluid and vasopressor management, assessing the success of weaning from mechanical ventilation, and can be used as an objective measure for the assessment of regional anesthesia and pain[14].

Duggappa DR et al., in their study on healthy parturients undergoing elective cesarean section under SAB, found that PI can be used to predict hypotension. Parturients with baseline PI >3.5 are at higher risk of developing hypotension following SAB compared to those with baseline PI ≤3.5[19]. Hypotension following spinal anesthesia was attributed to a decrease in systemic vascular resistance. The reduction of SVR may vary in parturient depending on various factors. This decrease in tone will correspond to higher PI values due to an increase in pulsatile components due to vasodilatation. Induction of sympathectomy by spinal anesthesia will cause a further decrease in peripheral vascular tone and increase pooling and hypotension[35–37].

Ginosar et al. compared photo plethysmography waveform analysis with other simple bedside assessments of sympathectomy, including BP changes and skin temperature changes. Assessing PI derived from quantitative photoplethysmography waveform analysis provides an earlier

and clearer indication of sympathetic blockade than the other clinical diagnostic modalities tested and is proven to be a reliable indicator of sympathectomy[38-39].

Changes in the sympathetic nervous system by pain can impact smooth muscle tone and can alter perfusion which can be successfully measured by PI. Pain induces vasoconstriction due to sympathetic stimulation, which also results in a decrease in PI. In a study by Surekha *et al.,* it was found that the change in PI could be a surrogate monitoring tool to determine the nociception intraoperatively after excluding the confounding factors in relatively fit (ASA physical status class I and II) surgical patients[40].

Similar results were reported in a study done by Chun-Lin Chu et al. on 80 patients in the postoperative anesthesia care unit. HR, MAP, Visual analog scale (VAS), and PI were recorded at the baseline and post-administration of IV injection of 3 mg morphine at 10, 20- and 30-minute intervals. It was observed that there was an increase in PI post-administration of analgesia and a weak correlation with the VAS score. It was concluded that a 12% increase in PI can be used as a discharge criterion in postoperative anesthesia care units. Such an increase in PI to analgesia was observed post-administration of 0.5 µg/kg IV injection of fentanyl. This was supported by a significant decrease in HR, and these changes in PI had a correlation with HR[41].

In a study by Mehandale et al., it was established that there is a positive correlation between pre-anesthetic variables and the prediction of hypotension following induction of general anesthesia using propofol. Higher Plethysmographic Variability Index (PVI) and reduction in blood pressure (BP) were observed in healthy adults. Specifically, higher PVI was associated with greater mean arterial pressure (MAP) reductions. Thus, PI is clinically very useful in predicting the likelihood of no hypotension in a given set of patients. The value of PI is inversely related to the vascular tone, though not in a linear fashion. Therefore, vasodilatation reflecting higher baseline PI has been associated with reductions in BP[20].

The use of propofol among patients with high PI is likely to cause fewer hemodynamic disturbances than those with PI < 1.05. The mechanism of propofol-induced hypotension involves action on the autonomic nervous system with an effect on the sympathetic as well as parasympathetic components. There is also evidence for the direct effect of propofol through endothelium-dependent and endothelium-independent pathways. Both culminate in vasodilatation. If the patient has significant peripheral vasoconstriction, that is, low PI, they are more likely to have hypotension. Similarly, if the patient already has low vascular tone (vasodilated and relatively compensated blood volume), indicated by higher PI, there is less possibility of hypotension[20].

A study by He et al. demonstrated that altering MAP levels through norepinephrine infusion led to varied responses in PI among septic shock patients. Specifically, the study found no significant and consistent change in PI across different MAP levels achieved by norepinephrine titration. Moreover, Magnin et al.'s study found that there are negative correlations between MAP and peripheral perfusion parameters, such as temperature gradients and capillary refill time. This suggests that lower MAP and higher doses of norepinephrine are associated with peripheral perfusion disorders in septic shock patients. The study also indicates a complex interaction between norepinephrine dosage, MAP, and peripheral perfusion. This highlights the need for individualized MAP targets to enhance peripheral tissue perfusion in these patients[42].

Studying the impact of Desflurane and Sevoflurane on PI is essential for ensuring hemodynamic stability, enhancing patient safety, tailoring anesthetic management, and optimizing surgical outcomes.

EFFECT OF INHALED ANESTHETICS ON PERFUSION INDEX

In a study conducted by Ryu et al., the effects of Desflurane and Sevoflurane on peripheral vasodilation were evaluated by measuring the PI in patients undergoing arthroscopic knee surgery. The study demonstrated that the PI remained significantly higher in the Desflurane group as

compared to the Sevoflurane group, both before and after nociceptive stimulation. This indicates a stronger vasodilatory effect with Desflurane. Furthermore, the Desflurane group had lower MAP, which was consistent with the higher PI values. This suggests that Desflurane may lead to more significant peripheral vasodilation than Sevoflurane at equivalent doses, potentially impacting the anesthesia's hemodynamic effects[21].

Oh et al. further studied the effects of Desflurane and Sevoflurane on perfusion index in noncardiac surgery patients. The retrospective study included 230 patient pairs, chosen from a larger group of 1680, who received one of the two anesthetics. The primary finding was that the intraoperative PI was significantly higher in the Desflurane group compared to the Sevoflurane group, with a median paired difference of 0.45 (95% CI 0.16 to 0.74, p=0.002). Additionally, the duration of PI below thresholds of 1.0 and 1.5 was significantly longer in the Sevoflurane group, indicating better peripheral perfusion with Desflurane. Despite these differences in PI; MAP and durations of low MAP were similar between the two groups, suggesting that the differences in PI were not associated with changes in MAP. The study concluded that while intraoperative PI was higher with Desflurane, the clinical impact of choosing between Desflurane and Sevoflurane based on PI could be minimal[13].

MATERIALS AND METHODS

SOURCE OF DATA:

A randomized controlled study was conducted in the Department of Anaesthesiology, Dayanand Medical College and Hospital in Ludhiana, following approval from the Institutional Ethics Committee. A total of 60 patients scheduled for elective surgery under general anesthesia were prospectively evaluated for inclusion in the study.

METHOD OF COLLECTION OF DATA:

A prospective, randomized study was conducted on 60 ASA I and II adult patients. The randomization process involved using computer-generated random numbers that were contained in sealed, sequentially numbered envelopes. These envelopes were then opened by an independent anesthesiologist. Written informed consent was obtained from all the selected patients for the study.

Inclusion criteria- Sixty adults of either sex, aged 18 to 65, belonging to the American Society of Anesthesiologists (ASA) Physical Status I and II, scheduled for elective surgery under general anesthesia, were included in the study.

Exclusion criteria- We excluded the following patients:

1. Receiving any medications that may affect vascular tone (eg vasoactive drugs, such as calcium channel blockers or angiotensin receptor blockers).
2. Known case of any cardiovascular or peripheral vascular disease (e.g. Diabetic vasculopathy or Raynaud's disease).
3. Medications that may affect sympathetic or parasympathetic tone(e.g. beta blockers or anticholinergics).
4. History of Diabetes mellitus.
5. Presence of any neurological or psychiatric diseases, including history of, or treatment for, substance abuse, anxiety, or depression.

GROUP ALLOCATION: A total of 60 patients were enrolled in the study and assigned randomly to one of two groups using consecutively numbered opaque sealed envelopes, as determined by a computer-generated random number list.

1. **Group D-** Included 30 patients in whom anesthesia was maintained using Desflurane.
2. **Group S**- Included 30 patients in whom anesthesia was maintained using Sevoflurane.

PREANAESTHETIC CHECKUP

A detailed pre-anesthetic check-up was done, including a comprehensive history (comorbidities, drug allergies), as well as a general physical and systemic examination. Patients were informed about the ongoing study, and written informed consent was obtained. The relevant investigations were sent and reviewed. All patients were kept fasting for 8 hrs for solids, 6 hrs for semisolids, and 2 hrs for clear liquids prior to surgery.

ANAESTHESIA TECHNIQUE

On arrival in the operating room, all patients were monitored using 5-lead electrocardiography, heart rate (HR), automated non-invasive blood pressure (NIBP), pulse oximetry using Masimo® Rad-97 monitor to measure peripheral oxygen saturation (SpO2), and PI was instituted. The pulse oximeter probe was placed on the index finger of the hand opposite to the arm where the non-invasive blood pressure cuff was positioned before the induction of general anesthesia. The baseline value was determined by taking the mean of three consecutive readings of PI, HR, SBP, DBP and MAP at 1-minute intervals.

After preoxygenation with 100% oxygen for three minutes using the standard face mask technique, anesthesia was induced with an intravenous injection of fentanyl 2µg/kg followed by 1% propofol 2mg/kg, titrated slowly until loss of verbal response. After administering 0.5 mg/kg of Atracurium, the patient's lungs were ventilated with oxygen for 3 minutes, followed by tracheal intubation using an appropriately sized endotracheal tube (ETT).

ETT was secured after ensuring bilateral air entry. Anesthesia was maintained with 50% nitrous oxide in oxygen, along with either Desflurane or Sevoflurane depending on group allocation. The anesthesiologist continuously adjusted the anesthetic vaporizer dial to maintain a value of 1.0 MAC during the study period. The MAC values were adjusted for age using the Dräger Primus anesthesia workstation algorithm. After achieving 1.0 MAC, all parameters, that is HR, PI, SBP, DBP, and MAP were continuously recorded every minute for 20 min, after induction of anesthesia. During the study period, if there was a >20% drop in SBP from baseline, it was managed with intravenous injections of Ephedrine in 6 mg increments. If the heart rate was less than 50 bpm or decreased by more than 30% below the baseline value (whichever is lower) at any time during the study period, it was managed with an intravenous bolus of 0.6mg Atropine. Under any of these circumstances, the subject was considered a dropout, and the related data was not included in the final analyses.

DURATION OF STUDY- 20 MINUTES

NUMBER OF CASES- 60

OUTCOME

PRIMARY OUTCOME: The primary outcome of the study was perfusion index.

SECONDARY OUTCOME: To compare heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure

STATISTICAL ANALYSIS:

The statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 21 (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows. The data was described in terms of range, mean (± standard deviation), median, frequencies (number of cases), and relative frequencies (percentages) as appropriate To assess the normal distribution of the data, a Kolmogorov-Smirnov test was utilized. The

comparison of quantitative variables between the study groups involved the use of the Student t-test for parametric data and the Mann-Whitney U test for non-parametric data. Categorical data was compared using the Chi-square ($\chi 2$) test, with the Fisher exact test being used when the expected frequency was less than 5. A probability value (p-value) of less than 0.05 was considered statistically significant.

Power and Sample Size:

The sample size was calculated to determine the 95% confidence interval for the PI, with a mean difference of 3.3 and a standard deviation of PI assumed to be 2.8 based on the study. Assuming a significance level (α error) of 0.05 and a power (1 - ß) of 99%, the effective sample size based on PI was calculated to be 26 in each group. This number was increased to 30 in each group to account for predicted dropouts from treatment. The formula used is as under:

$n = (\sigma 12 + \sigma 22) (Z\alpha + Z\beta)^2 / (m1 – m2)^2$

Where

$Z\alpha$ = Value of standard normal variate corresponding to α level of significance (1.96)

$Z\beta$ = The standard normal deviate for desired power (1.28)

m = Average

σ = Standard deviation

Assumptions:

From the study conducted by Ryu et al [1]

Mean Group (m1) = 9.1

Mean Group (m2) =5.8

Coefficient of variation = 150%

Standard deviation Group ($\sigma 1$) =2.8

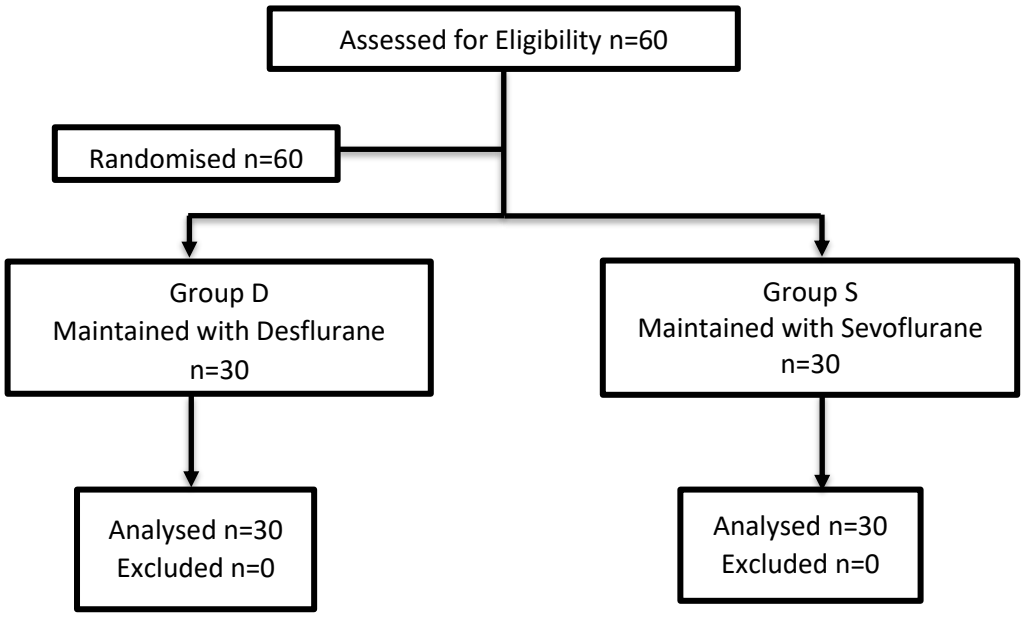
Standard deviation ($\sigma 2$) = 2.7

OBSERVATIONS AND RESULTS

The present observational study was conducted prospectively in the department of Anesthesiology, DMCH Ludhiana, on a total of 60 adult patients of either sex, between 18 and 60 years of age, belonging to ASA grade I or II, scheduled for elective surgeries under general anesthesia.

The study aimed to compare the vasodilatory properties of Desflurane and Sevoflurane using the perfusion index as a marker. A total of 60 patients were recruited in the study and allocated to either group (Group D or Group S) randomly. Group D was maintained on Desflurane, and Group S was on Sevoflurane after induction with general anesthesia. On arrival in the operating room, all patients were monitored using standard monitoring. The baseline value was taken as the mean of three consecutive readings of PI, HR, SBP, DBP, and MAP at 1-minute intervals. Maintenance of anaesthesia was established with 50% Nitrous oxide in Oxygen along with either Desflurane or Sevoflurane, depending on group allocation. After achieving 1.0 MAC, all parameters, that is, HR, PI, SBP, DBP and MAP, were continuously recorded every minute for 20 min.

Figure 1: CONSORT Flow diagram of the study



DEMOGRAPHIC PROFILE

Table 1: Mean age distribution of the patients.

		GROUP D		GROUP S		Total	Chi-square value	p-value
		GROUP D	GROUP D	GROUP S	GROUP S			
AGE	< 30	10	33.3%	12	40.0%	22	1.14	0.767
	31-40	15	50.0%	11	36.7%	26		
	41-50	3	10.0%	4	13.3%	7		
	> 50	2	6.7%	3	10.0%	5		
Total		30	100.0%	30	100.0%	60		

The patients in Group D were distributed as 10(33.3%) patients less than 30yrs of age, 15(50.0%) patients between 31-40 years ,3(10.0%) patients between 41-50 years, 2(6.7%) patients between 51-60 years of age. In group S, patients were distributed as 12(40.0%) patients less than 30yrs of age, 11(36.7%) patients between 31-40 years 4(13.3%) patients between 41-50 years, 3(10.0%) patients between 51-60 years of age. There was no statistically significant difference between the two groups concerning age (p 0.767)

Figure 2: Mean age distribution of the patients.

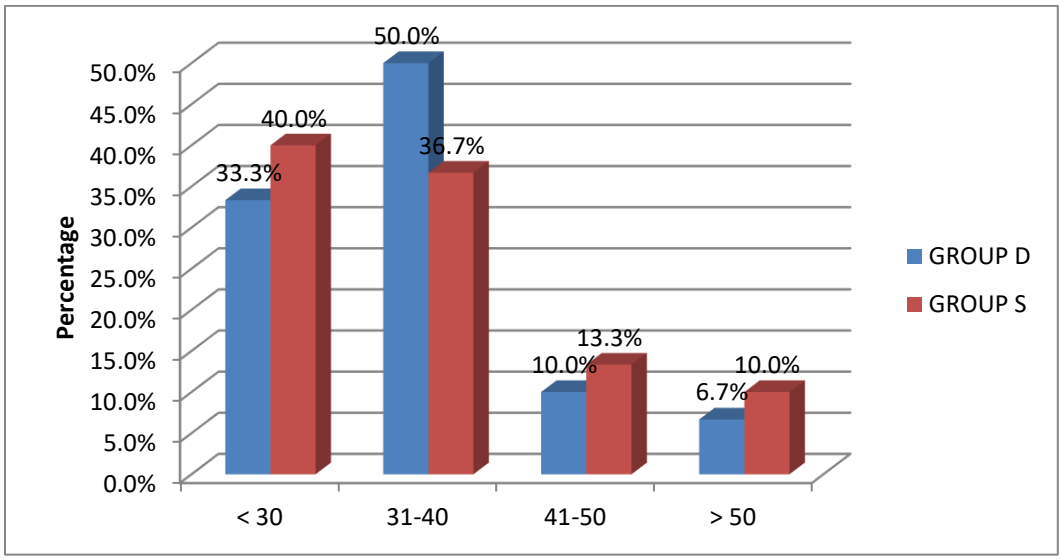


Table 2: Gender Distribution of the patients

		GROUP D		GROUP S		Total	Chi-square value	p-value
		GROUP D	GROUP D	GROUP S	GROUP S			
Gender	F	16	53.3%	17	56.7%	33	0.067	0.795
	M	14	46.7%	13	43.3%	27		
Total		30	100.0%	30	100.0%	60		

53.3% of the patients in the Desflurane group were females, and 46.7% were males, whereas, in the Sevoflurane group, 56.7% were females, and 43.3% were males. Both groups were comparable concerning gender distribution (p-value of 0.795).

Figure 3: Gender Distribution of the patients

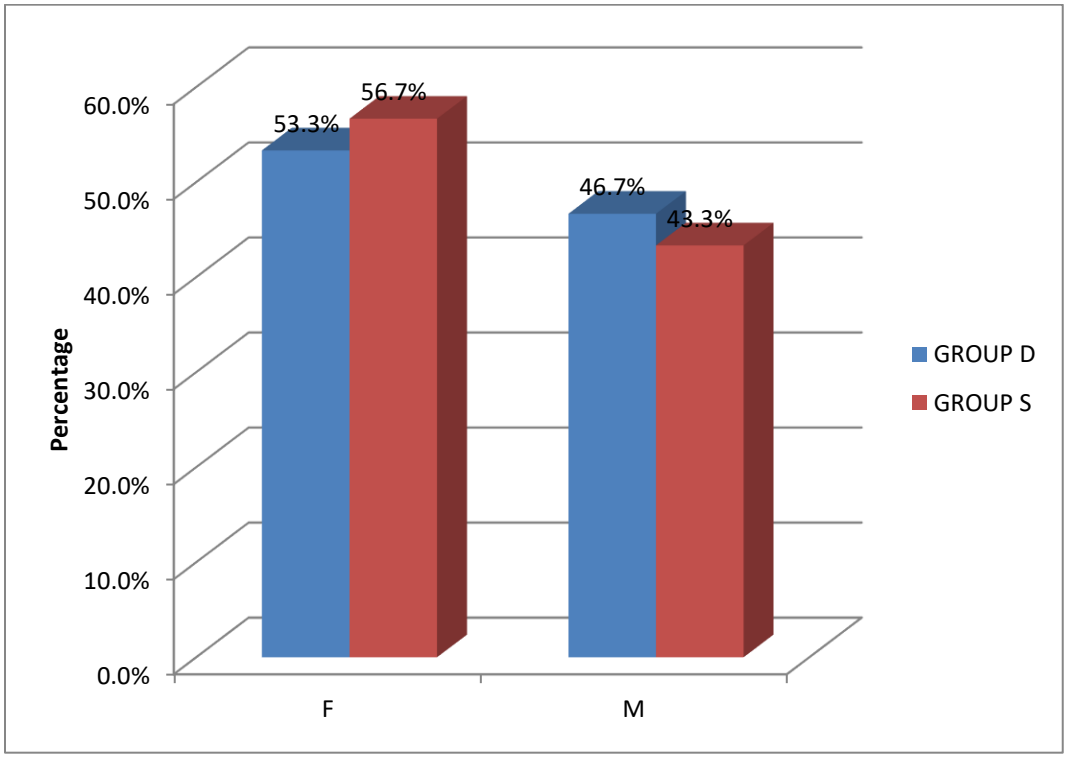
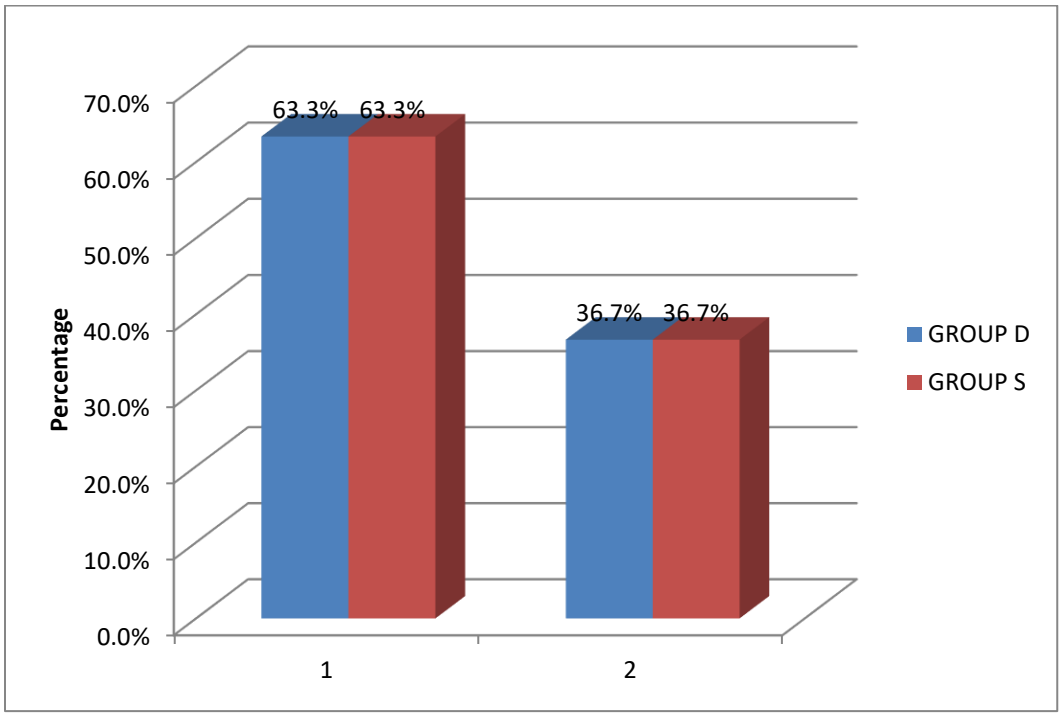


Table 3: ASA Physical status of the patients.

		GROUP D		GROUP S		Total	Chi-square value	p-value
		GROUP D	GROUP D	GROUP S	GROUP S			
ASA	1	19	63.3%	19	63.3%	38	0.000	1.000
	2	11	36.7%	11	36.7%	22		
Total		30	100.0%	30	100.0%	60		

The Desflurane group comprised 63.3%(19) ASA I and 36.7%(11) ASA II patients. Similarly, the Sevoflurane group had 63.3% (19) ASA I and 36.7% (11) ASA II patients. Both the groups were statistically comparable (p-value 1.000)

Figure 4: ASA physical status of the patients.



PARAMETERS OF STUDY

Table 4: The mean of baseline vital parameters

	GROUP D		GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline HR	77.47	9.38	81.60	12.93	-1.417	0.162	-4.13	2.92	-9.97	1.70
Baseline SBP	118.30	11.32	121.17	11.61	-1.274	0.203	-2.87	2.96	-8.79	3.06
Baseline DBP	74.70	7.91	78.37	9.96	-1.468	0.142	-3.67	2.32	-8.32	0.98
Baseline MAP	89.23	8.50	92.63	10.20	-1.399	0.162	-3.40	2.42	-8.25	1.45

The mean baseline HR was 77.47±9.38bpm in group D and 81.60±12.93bpm in group S, SBP was 118.30 ±11.32 mmHg in group D and 121.17±11.61mmHg in group S, DBP was 74.70±7.91mmHg in group D and 78.37±9.96mmHg in group S, MAP was 89.23±8.50mmHg in group D and 92.63±10.20mmHg in group S. Both the group were statistically comparable concerning baseline parameters

Figure 5: The mean of baseline parameters

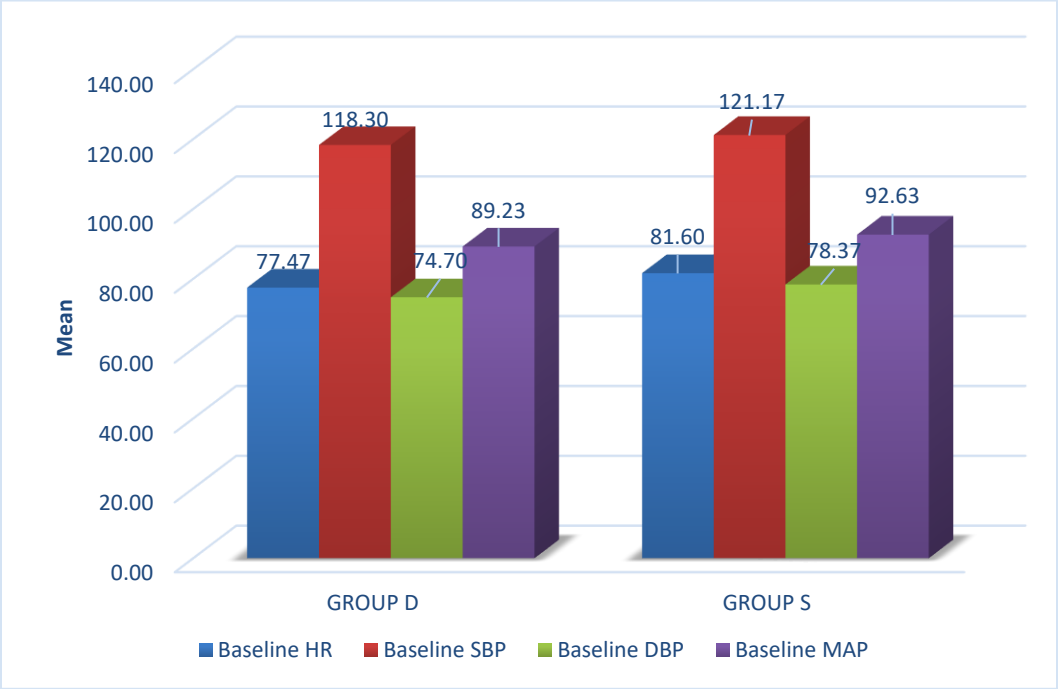


Table 5: Baseline mean Perfusion index

	GROUP D		GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline PI	3.05	1.38	3.97	2.64	-0.910	0.363	-0.92	0.54	-2.01	0.17

The mean baseline PI was 3.05±1.38 in group D and 3.97±2.64 in group S.

Figure 6: Baseline mean PI

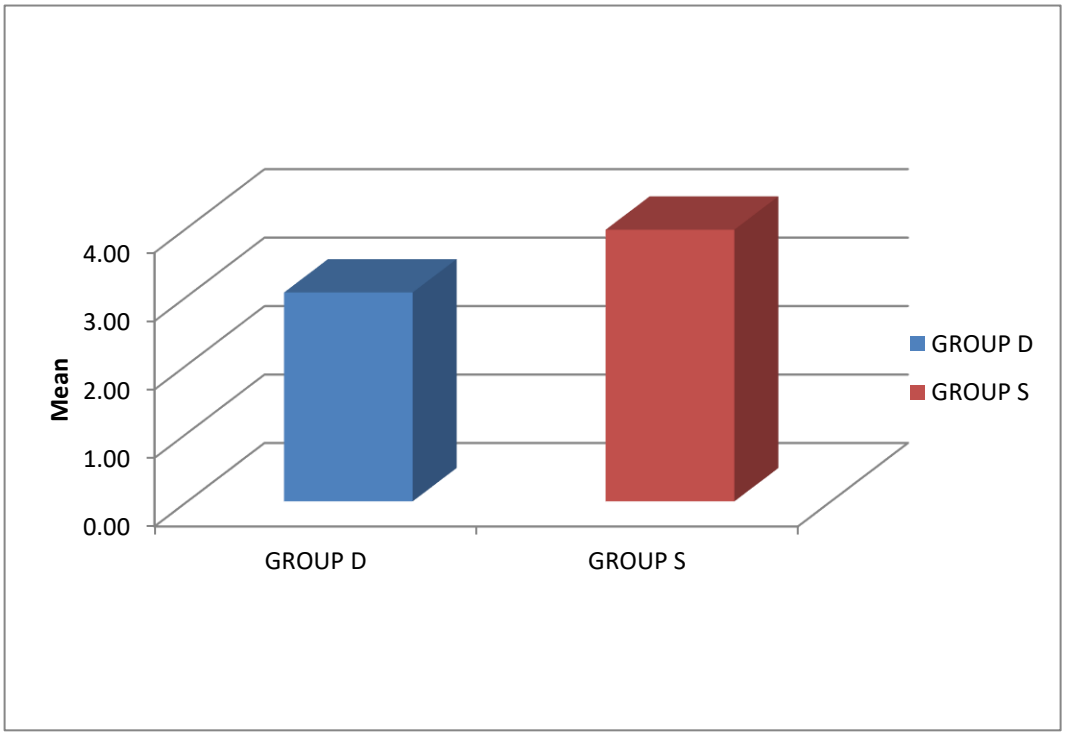


Table 6: Trends of mean values of intra-operative PI

	GROUP D		GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Mean	Std. Error	Lower	Upper
PI AT 1MIN	6.81	2.16	5.29	3.27	-2.462	**0.014**	1.52	0.72	0.09	2.95
PI AT 2MIN	7.13	2.07	5.54	3.48	-2.640	**0.008**	1.59	0.74	0.11	3.07
PI AT 3MIN	6.97	1.97	5.56	3.60	-2.448	**0.014**	1.41	0.75	-0.09	2.91
PI AT 4MIN	7.20	2.23	5.46	3.37	-2.640	**0.008**	1.74	0.74	0.27	3.22
PI AT 5MIN	7.30	2.26	5.55	3.27	-2.714	**0.007**	1.75	0.73	0.30	3.21
PI AT 6MIN	7.42	2.44	5.37	3.02	-2.928	**0.003**	2.05	0.71	0.63	3.47
PI AT 7MIN	7.41	2.46	5.38	3.10	-2.773	**0.006**	2.02	0.72	0.57	3.47
PI AT 8MIN	7.41	2.57	5.61	3.34	-2.610	**0.009**	1.79	0.77	0.25	3.33.
PI AT 9MIN	7.39	2.45	5.57	3.44	-2.832	**0.005**	1.82	0.77	0.27	3.36
PI AT 10MIN	7.36	2.50	5.49	3.24	-2.818	**0.005**	1.88	0.75	0.38	3.37
PI AT 11MIN	7.32	2.39	5.62	3.29	-2.780	**0.005**	1.69	0.74	0.21	3.18
PI AT 12MIN	7.09	2.53	5.46	3.43	-2.440	**0.015**	1.63	0.78	0.07	3.19
PI AT 13MIN	7.20	2.41	5.22	3.29	-2.869	**0.004**	1.99	0.74	0.50	3.48

PI AT 14MIN	6.89	2.58	5.47	3.39	-2.159	**0.031**	1.42	0.78	-0.14	2.98
PI AT 15MIN	6.88	2.63	5.53	3.51	-2.137	**0.033**	1.34	0.80	-0.26	2.95
PI AT 16MIN	6.90	2.71	5.55	3.51	-2.070	**0.038**	1.35	0.81	-0.28	2.97
PI AT 17MIN	6.89	2.69	5.49	3.34	-2.019	**0.044**	1.40	0.78	-0.17	2.97
PI AT 18MIN	6.91	2.68	5.38	3.23	-2.160	**0.031**	1.53	0.77	0.00	3.07
PI AT 19MIN	6.82	2.67	5.30	3.06	-2.255	**0.024**	1.51	0.74	0.03	3.00
PI AT 20MIN	6.78	2.76	5.44	3.26	-2.181	**0.029**	1.34	0.78	-0.23	2.90

PI was significantly higher in the Desflurane group as compared to the Sevoflurane group throughout the study period.

Figure 7: Trends of mean values of intra-operative PI

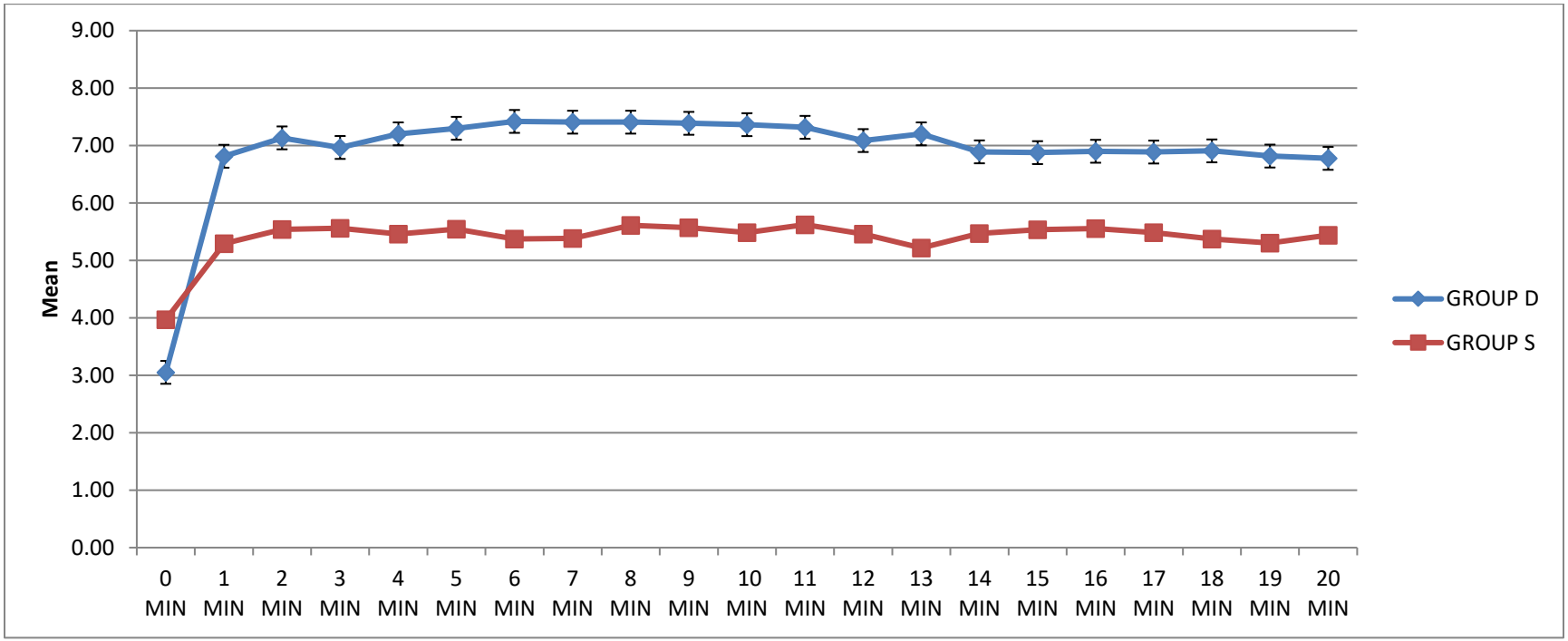


Table 7: Comparison of Mean intraoperative PI with Baseline in Group D

	GROUP D		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline PI	3.05	1.38						
Average PI	6.91	2.25	-11.681	**0.001**	-3.86	1.81	-4.53	-3.18

In the Desflurane group, PI increased from the baseline value of 3.05 to 6.91 at 1.0 MAC with a significant mean difference of 3.86 (p-value 0.001)

Table:8 Comparison of Mean Intraoperative PI with Baseline in Group S

	GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline PI	3.97	2.64						
Average PI	5.39	3.18	-3.104	**0.004**	-1.42	2.51	-2.36	-0.49

In the Sevoflurane group, PI increased from a baseline value of 3.97 to 5.39 at 1.0 MAC with a significant mean difference of 1.42 (p-value 0.004).

Table 9: Comparison of the change in PI between Desflurane and Sevoflurane groups.

	GROUP D		GROUP S	
	Mean	SD	Mean	SD
Baseline PI	3.05	1.38	3.97	2.64
Average PI	6.91	2.25	5.39	3.18
Z, P-VALUE	-11.681	0.001	-3.104	0.004
Difference	-3.86	1.81	-1.42	2.51
Z, P-VALUE	-5.49		**0.001**	

The mean intraoperative PI was significantly higher in the Desflurane group compared to the Sevoflurane group.
(p-value 0.001)

Figure 8: Relative change in PI (baseline to average)

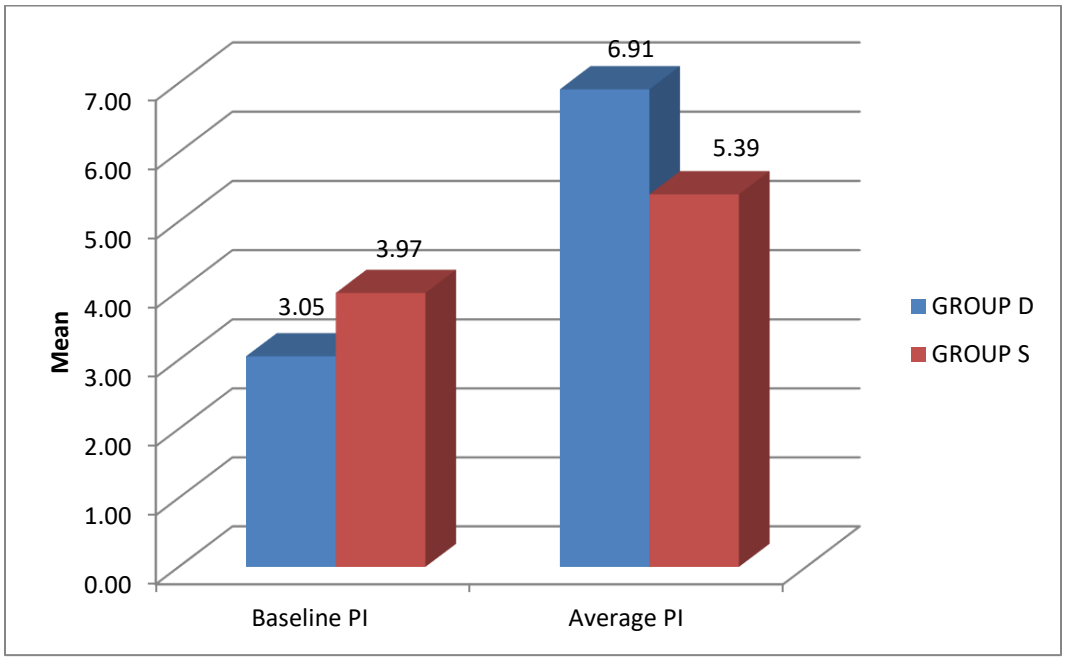


Table 10: Trends of mean values of intra-operative HR (bpm)

	GROUP D		GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Mean	Std. Error	Lower	Upper
HR AT 1 MIN	89.00	8.96	88.80	15.09	-0.785	0.433	0.20	3.20	-6.21	6.61
HR AT 2 MIN	91.43	8.26	87.27	13.96	-1.791	0.073	4.17	2.96	-1.76	10.09
HR AT 3 MIN	91.93	8.17	87.70	13.78	-1.806	0.071	4.23	2.93	-1.62	10.09
HR AT 4 MIN	91.53	9.45	86.10	13.67	-2.103	**0.035**	5.43	3.03	-0.64	11.51
HR AT 5 MIN	91.80	8.13	85.90	12.19	-2.590	**0.010**	5.90	2.68	0.55	11.25
HR AT 6 MIN	91.33	8.17	85.70	11.72	-2.442	**0.015**	5.63	2.61	0.41	10.85
HR AT 7 MIN	91.73	8.63	84.97	10.04	-2.782	**0.005**	6.77	2.42	1.93	11.61
HR AT 8 MIN	91.57	8.50	84.77	10.91	-2.473	**0.013**	6.80	2.52	1.75	11.85
HR AT 9 MIN	91.03	8.39	83.80	10.77	-2.738	**0.006**	7.23	2.49	2.25	12.22
HR AT10 MIN	91.37	8.63	84.07	10.11	-2.990	**0.003**	7.3 0	2.43	2.44	12.16
HR AT 11 MIN	91.00	9.57	83.53	9.97	-2.821	**0.005**	7.47	2.52	2.42	12.52

HR AT 12 MIN	91.53	10.11	84.43	10.18	-2.614	**0.009**	7.10	2.62	1.86	12.34
HR AT 13 MIN	91.67	10.30	84.63	9.74	-2.657	**0.008**	7.03	2.59	1.85	12.21
HR AT 14 MIN	91.70	9.20	84.53	9.54	-2.967	**0.003**	7.17	2.42	2.32	12.01
HR AT 15 MIN	90.57	8.02	83.60	9.42	-3.041	**0.002**	6.97	2.26	2.44	11.49
HR AT 16 MIN	90.77	9.36	83.13	9.57	-2.878	**0.004**	7.63	2.44	2.74	12.52
HR AT 17 MIN	91.03	8.64	83.37	9.31	-3.139	**0.002**	7.67	2.32	3.03	12.31
HR AT 18 MIN	90.60	8.36	83.83	8.65	-3.133	**0.002**	6.77	2.20	2.37	11.16
HR AT 19 MIN	90.63	8.09	84.57	8.83	-2.659	**0.008**	6.07	2.19	1.69	10.44
HR AT 20 MIN	90.23	8.48	84.07	9.24	-2.565	**0.010**	6.17	2.29	1.58	10.75

HR after 4 minutes was significantly greater in the Desflurane group than the Sevoflurane group.

Figure 9: Trends of mean values of intra-operative heart rate (HR) (bpm)

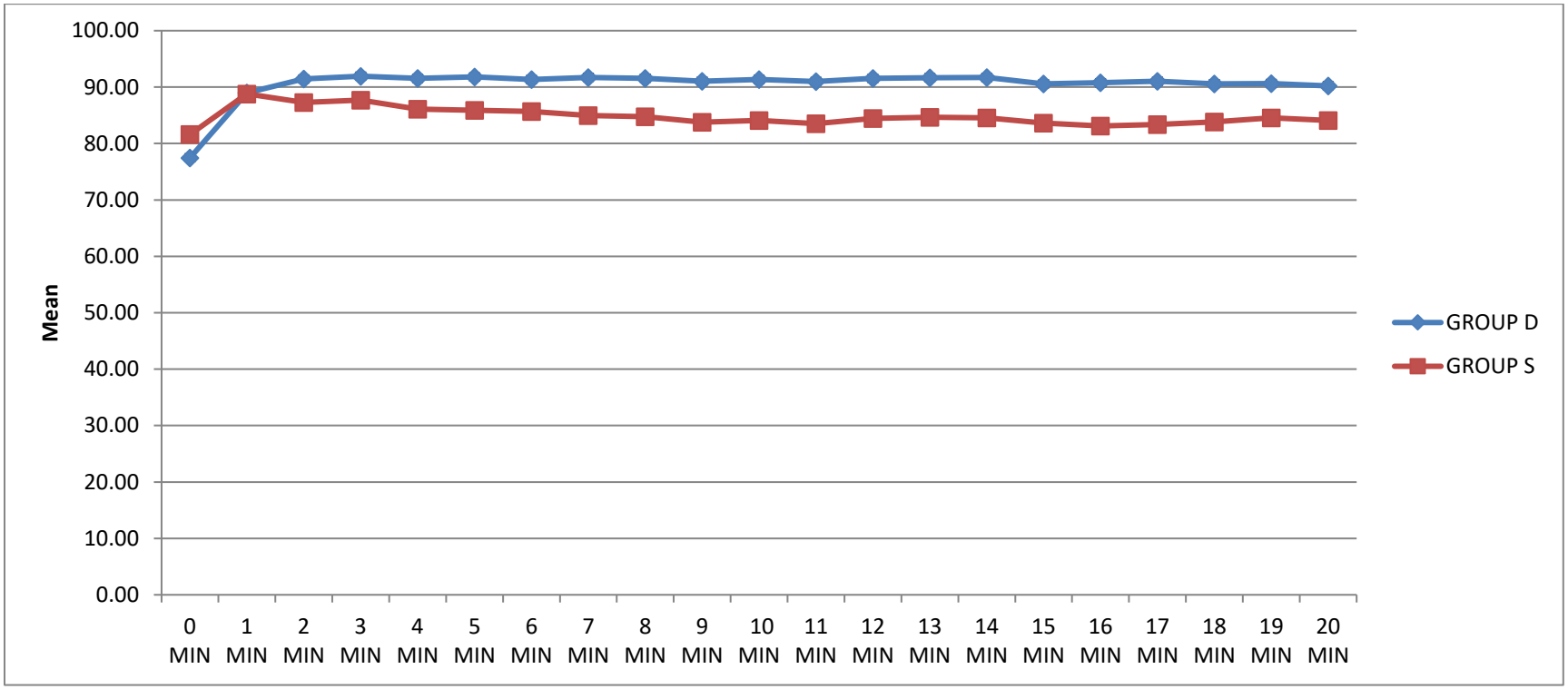


Table 11: Comparison of Mean intraoperative HR with baseline in Group D

	GROUP D		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline HR	77.47	9.38						
Average HR	90.47	6.89	-7.230	**0.001**	-13.01	9.85	-16.69	-9.33

In the Desflurane group, mean HR increased from a baseline value of 77.47bpm to 90.47bpm at 1.0 MAC with a mean difference of 13.01bpm, which is statistically significant (95% CI 16.69 to 9.33, p= 0.001)

Table 12: Comparison of Mean intraoperative HR with baseline in Group S

	GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline HR	81.60	12.93						
Average HR	84.78	9.71	-1.908	0.066	-3.18	9.13	-6.59	0.23

In the Sevoflurane group, the mean HR increased from a baseline value of 81.60bpm to 84.78bpm at 1.0 MAC with a mean difference of 3.18 bpm which is statistically non-significant (p-value 0.066)

Table 13: Comparison of the change in HR between Desflurane and Sevoflurane groups

	GROUP D		GROUP S	
	Mean	SD	Mean	SD
Baseline HR	77.47	9.38	81.60	12.93
Average HR	90.47	6.89	84.78	9.71
Z, P-VALUE	-7.230	0.001	-1.908	0.066
Difference	-13.01	9.85	-3.18	9.13
Z, P-VALUE	-3.65		**0.001**	

The increase in HR is more significant in the Desflurane group than in the Sevoflurane Group at 1.0 MAC relative to the baseline value (p-value 0.001).

Figure 10: Relative change of HR (baseline to average)

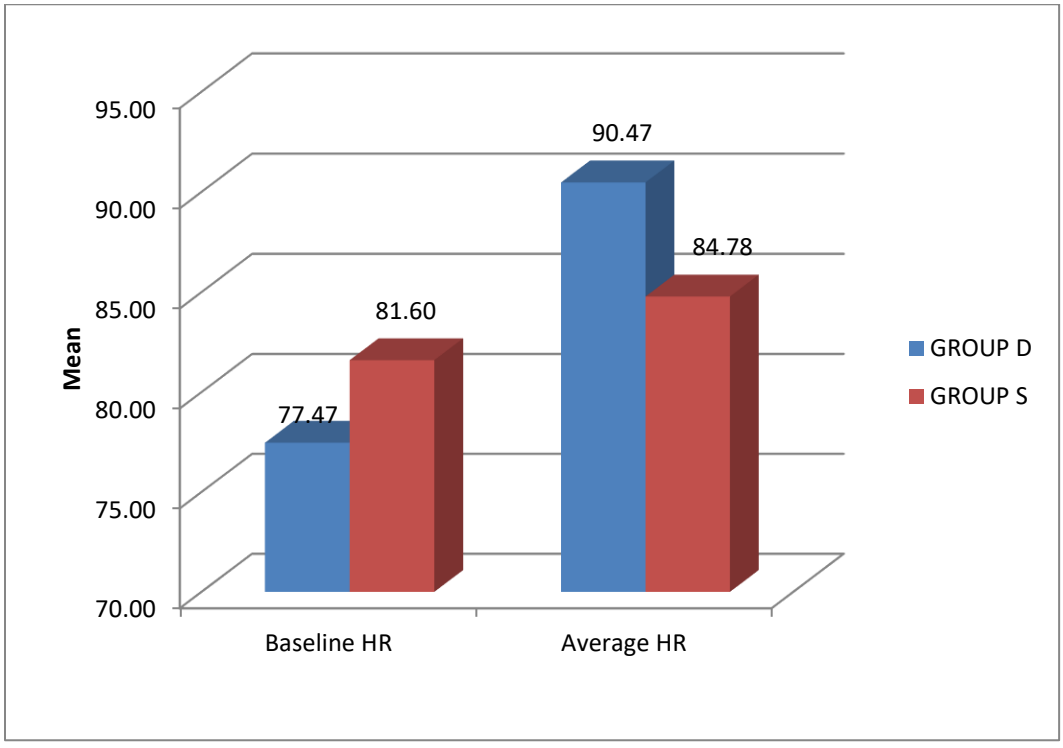


Table 14: Trends of mean values of intra-operative Systolic blood pressure (SBP) in mmHg

	GROUP D		GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Mean	Std. Error	Lower	Upper
SBP AT 1 MIN	104.07	16.61	113.47	10.04	-3.235	**0.001**	-9.40	3.54	-16.49	-2.31
SBP AT 2 MIN	102.57	15.14	112.13	9.74	-3.167	**0.002**	-9.57	3.29	-16.15	-2.99
SBP AT 3 MIN	101.90	14.09	111.60	10.78	-3.309	**0.001**	-9.70	3.24	-16.18	-3.22
SBP AT 4 MIN	99.57	11.83	110.87	10.44	-3.890	**0.001**	-11.30	2.88	-17.07	-5.53
SBP AT 5 MIN	98.27	10.01	112.20	10.26	-4.617	**0.001**	-13.93	2.62	-19.17	-8.69
SBP AT 6 MIN	97.70	11.07	112.00	8.89	-4.608	**0.001**	-14.30	2.59	-19.49	-9.11
SBP AT 7 MIN	96.93	9.37	112.23	8.63	-5.158	**0.001**	-15.30	2.32	-19.95	-10.65
SBP AT 8 MIN	97.57	9.71	112.70	9.37	-4.830	**0.001**	-15.13	2.46	-20.07	-10.20
SBP AT 9 MIN	97.87	9.72	111.03	8.39	-4.609	**0.001**	-13.17	2.34	-17.86	-8.48
SBP AT 10 MIN	97.57	10.93	112.63	9.21	-4.578	**0.001**	-15.07	2.61	-20.29	-9.84
SBP AT 11 MIN	98.07	10.38	112.03	9.03	-4.476	**0.001**	-13.97	2.51	-19.00	-8.94

SBP AT 12 MIN	98.10	10.40	113.10	9.54	-4.715	**0.001**	-15.00	2.58	-20.16	-9.84
SBP AT 13 MIN	98.67	9.57	114.23	9.29	-5.091	**0.001**	-15.57	2.44	-20.44	-10.69
SBP AT 14 MIN	100.13	11.48	113.77	8.66	-4.276	**0.001**	-13.63	2.63	-18.89	-8.38
SBP AT 15 MIN	99.27	10.69	113.23	7.93	-4.578	**0.001**	-13.97	2.43	-18.83	-9.10
SBP AT 16 MIN	100.53	12.15	112.70	7.98	-3.921	**0.001**	-12.17	2.65	-17.48	-6.86
SBP AT 17 MIN	101.40	11.41	114.37	8.03	-4.128	**0.001**	-12.97	2.55	-18.06	-7.87
SBP AT 18 MIN	101.07	12.17	113.60	6.73	-4.085	**0.001**	-12.53	2.54	-17.62	-7.45
SBP AT 19 MIN	101.00	12.43	113.23	7.07	-3.886	**0.001**	-12.23	2.61	-17.46	-7.00
SBP AT 20 MIN	101.23	12.68	113.63	7.99	-3.722	**0.001**	-12.40	2.74	-17.88	-6.92

SBP remained significantly lower in Group D as compared to Group S throughout the study period

Figure 11: Trends of mean values of intra-operative systolic blood pressure (SBP) (mmHg)

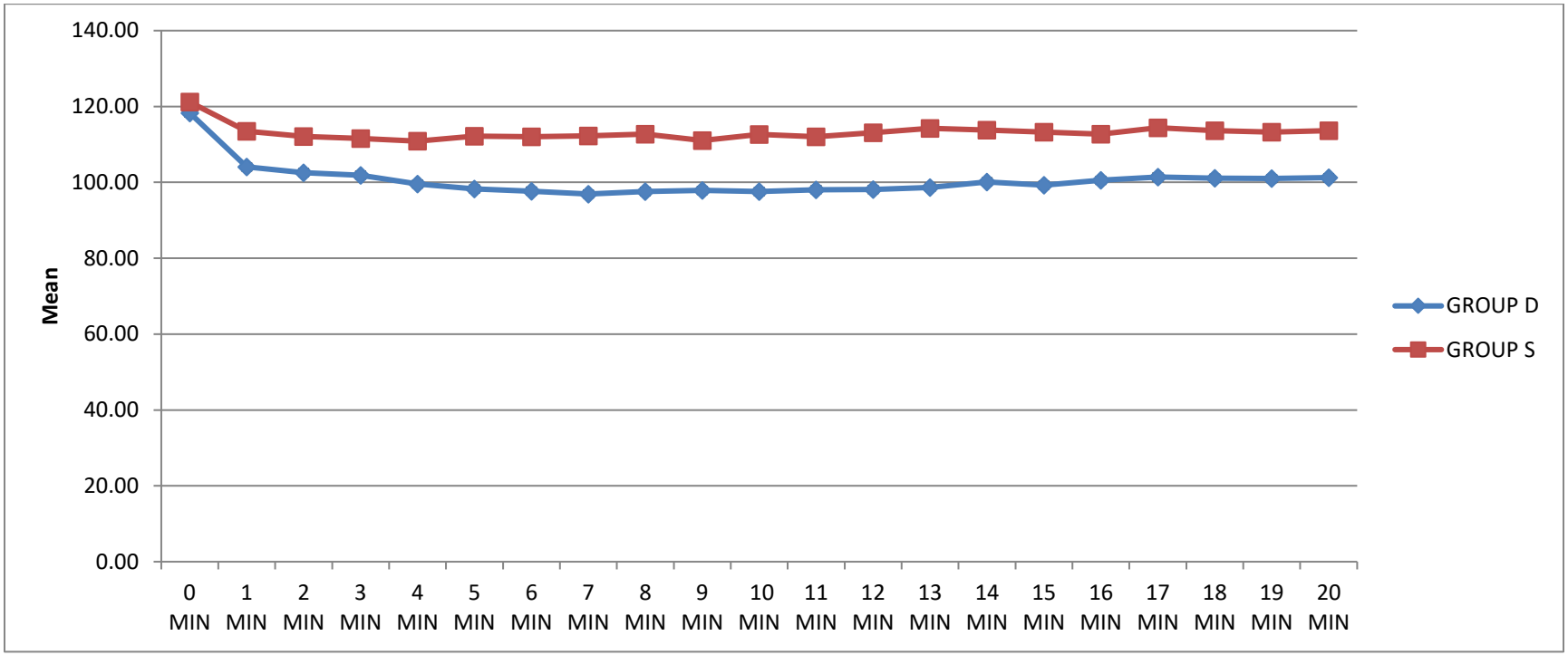


Table 15: Comparison of mean intraoperative SBP to Baseline in Group D

	GROUP D		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline SBP	118.30	11.32						
Average SBP	100.56	10.36	11.056	**0.001**	17.74	8.79	14.46	21.02

In the Desflurane group, BP decreased from a baseline value of 118.30mmHg to 100.56mmHg at 1.0 MAC with a mean difference of 17.74mmHg which is statistically significant (p-value 0.001)

Table 16: Comparison of mean intraoperative SBP to Baseline in Group S

	GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline SBP	121.17	11.61						
Average SBP	113.14	7.10	4.513	**0.001**	8.03	9.74	4.39	11.67

In the Sevoflurane group, SBP decreased from a baseline value of 121.17mmHg to 113.14mmHg at 1.0 MAC with a mean difference of 8.03mmHg which is statistically significant (p-value 0.001)

Table 17: Comparison of the change in SBP between Desflurane and Sevoflurane groups

	GROUP D		GROUP S	
	Mean	SD	Mean	SD
Baseline SBP	118.30	11.32	121.17	11.61
Average SBP	100.56	10.36	113.14	7.10
Z, P-VALUE	11.056	0.001	4.513	0.001
Difference	17.74	8.79	8.03	9.74
Z, P-VALUE	-4.15		**0.001**	

Both agents caused a significant decrease in SBP from baseline. Desflurane reduced SBP by 17.74mmHg from baseline, whereas Sevoflurane decreased SBP by 8.03mmHg. Change in SBP from baseline is more with Group D as compared to Group S (p-value 0.001)

Figure 12: Relative change of SBP (baseline to average)

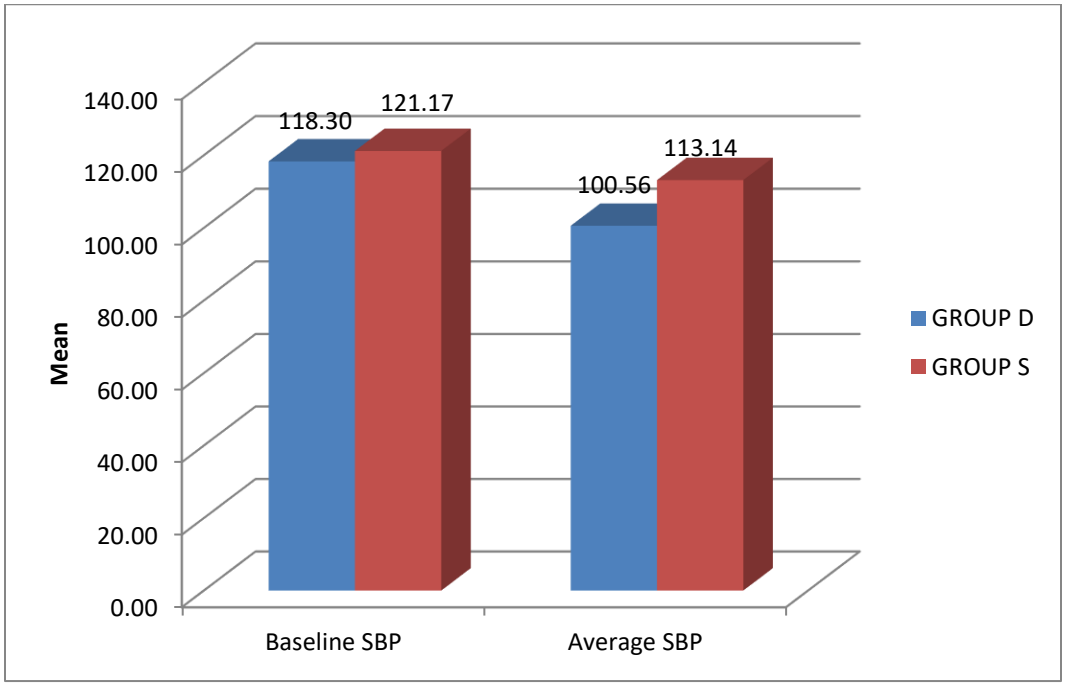


Table 18: Trends of mean values of intra-operative Diastolic blood pressure (DBP) (mmHg)

	GROUP D		GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Mean	Std. Error	Lower	Upper
DBP AT 1 MIN	67.30	8.53	72.67	9.09	-2.337	**0.019**	-5.37	2.28	-9.92	-0.81
DBP AT 2 MIN	66.00	7.43	70.73	10.17	-1.999	**0.046**	-4.73	2.30	-9.34	-0.13
DBP AT 3 MIN	64.43	6.95	70.07	9.44	-2.391	**0.017**	-5.63	2.14	-9.92	-1.35
DBP AT 4 MIN	64.10	5.36	70.70	8.27	-3.457	**0.001**	-6.60	1.80	-10.20	-3.00
DBP AT 5 MIN	63.53	5.89	69.97	7.42	-3.406	**0.001**	-6.43	1.73	-9.89	-2.97
DBP AT 6 MIN	62.57	5.24	70.60	7.77	-3.836	**0.001**	-8.03	1.71	-11.46	-4.61
DBP AT 7 MIN	62.80	5.80	70.33	7.88	-3.480	**0.001**	-7.53	1.79	-11.11	-3.96
DBP AT 8 MIN	62.90	4.92	70.30	8.27	-3.659	**0.001**	-7.40	1.76	-10.92	-3.88
DBP AT 9 MIN	62.23	4.38	71.10	9.32	-3.874	**0.001**	-8.87	1.88	-12.63	-5.10
DBP AT 10 MIN	63.17	4.77	70.80	8.60	-3.528	**0.001**	-7.63	1.79	-11.23	-4.04
DBP AT 11 MIN	64.27	4.83	69.57	7.86	-2.828	**0.005**	-5.30	1.68	-8.67	-1.93

DBP AT 12 MIN	64.70	4.74	71.57	7.96	-3.620	**0.001**	-6.87	1.69	-10.25	-3.48
DBP AT 13 MIN	64.37	4.89	71.53	8.45	-3.598	**0.001**	-7.17	1.78	-10.73	-3.60
DBP AT 14 MIN	64.67	5.53	71.63	8.56	-3.428	**0.001**	-6.97	1.86	-10.69	-3.24
DBP AT 15 MIN	64.77	5.53	71.23	8.13	-3.125	**0.002**	-6.47	1.79	-10.06	-2.87
DBP AT 16 MIN	64.70	6.18	70.87	7.73	-3.111	**0.002**	-6.17	1.81	-9.78	-2.55
DBP AT 17 MIN	63.47	4.68	70.57	7.71	-3.815	**0.001**	-7.10	1.65	-10.40	-3.80
DBP AT 18 MIN	63.53	5.59	71.53	6.44	-4.272	**0.001**	-8.00	1.56	-11.12	-4.88
DBP AT 19 MIN	64.20	5.33	70.70	7.21	-3.288	**0.001**	-6.50	1.64	-9.78	-3.22
DBP AT 20 MIN	65.10	6.48	69.87	6.70	-2.607	**0.009**	-4.77	1.70	-8.17	-1.36

DBP remained significantly lower in Group D as compared to Group S throughout the study period

Figure 13: Trends of mean values of intra-operative Diastolic blood pressure (DBP) (mmHg)

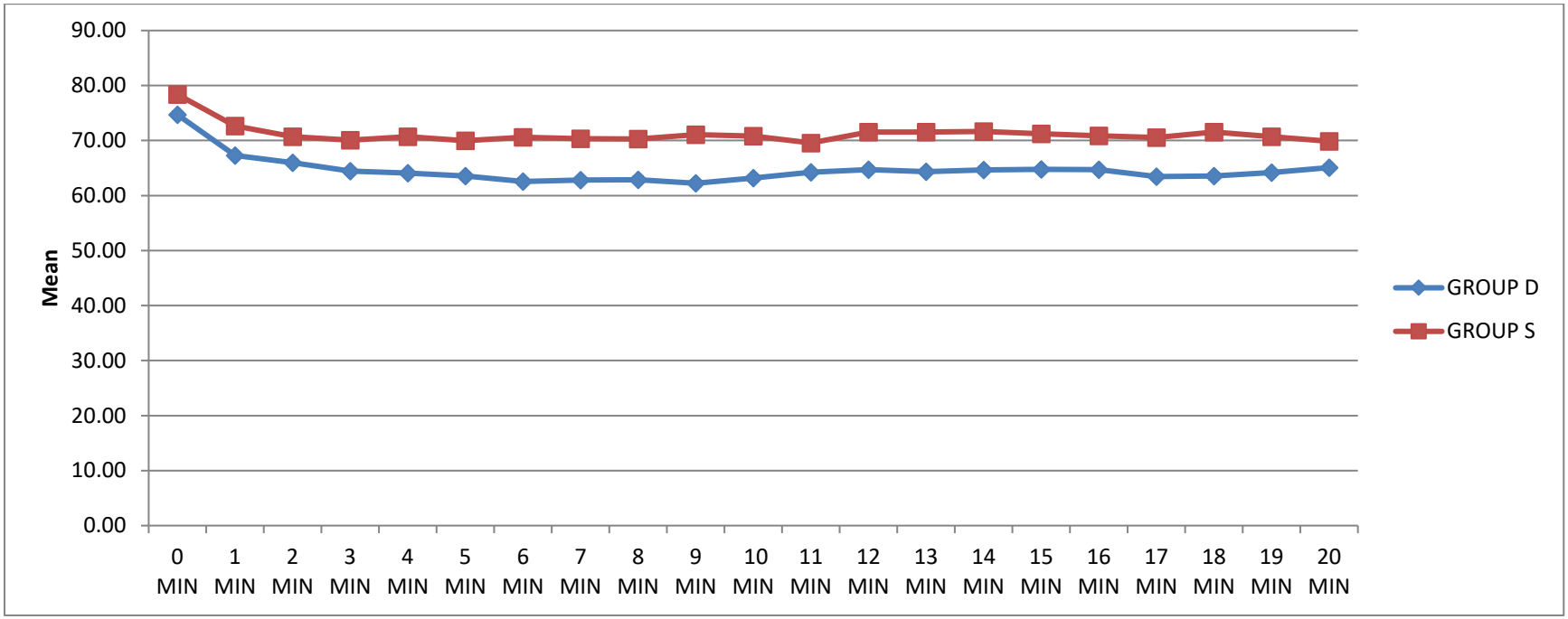


Table 19: Comparison of Mean intraoperative DBP with Baseline in Group D

	GROUP D		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline DBP	74.70	7.91						
Average DBP	64.64	3.81	8.608	**0.001**	10.06	6.40	7.67	12.45

In the Desflurane group, DBP decreased from a baseline value of 74.70mmHg to 64.64mmHg at 1.0 MAC with a mean difference of 10.06mmHg which is statistically significant (p-value 0.001)

Table 20: Comparison of Mean intraoperative DBP with Baseline in Group S

	GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline DBP	78.37	9.96						
Average DBP	71.18	7.06	5.414	**0.001**	7.19	7.27	4.47	9.91

In the Sevoflurane group, DBP decreased from a baseline value of 78.37mmHg to 71.18mmHg at 1.0 MAC with a mean difference of 7.19mmHg which is statistically significant (p-value 0.001)

Table 21: Comparison of the change in DBP between Desflurane and Sevoflurane groups

	GROUP D		GROUP S	
	Mean	SD	Mean	SD
Baseline DBP	74.70	7.91	78.37	9.96
Average DBP	64.64	3.81	71.18	7.06
Z, P-VALUE	8.608	0.001	5.414	0.001
Difference	10.06	6.40	7.19	7.27
Z, P-VALUE	-2.00		**0.046**	

Both agents caused a significant decrease in DBP from baseline. Desflurane reduced DBP by 10.06mmHg from baseline, whereas Sevoflurane decreased DBP by 7.19mmHg. Change in DBP from baseline is more with Group D as compared to Group S (p-value 0.046).

Figure 14: Relative change of DBP (baseline to average)

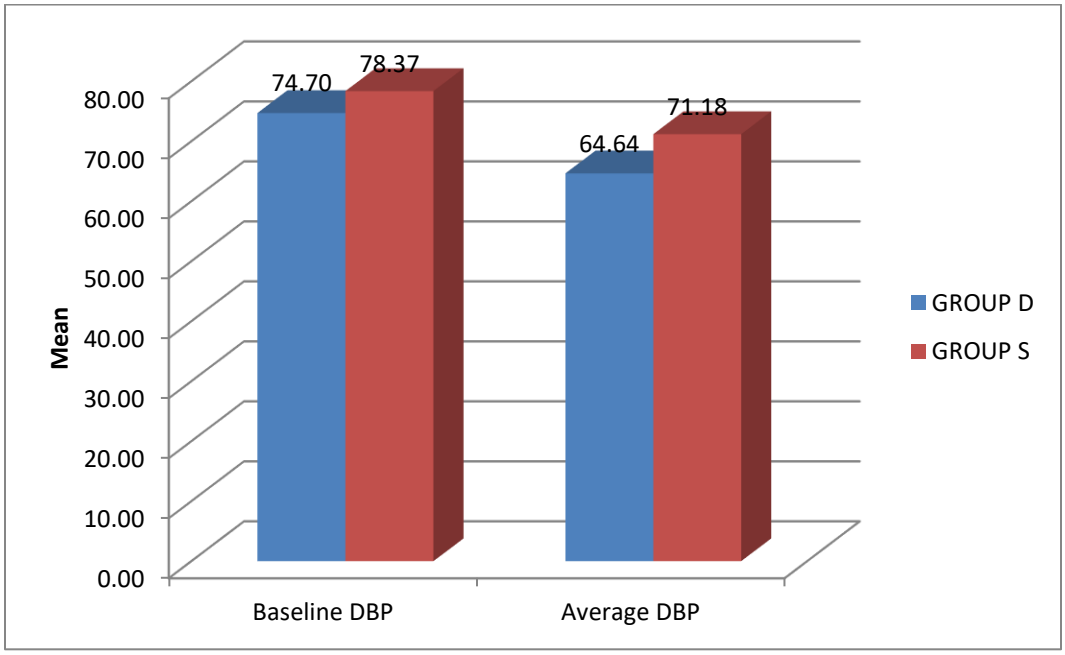


Table 22: Trends of mean values of intra-operative MAP.

	GROUP D		GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD	Mean	SD			Mean	Std. Error	Lower	Upper
MAP AT 1 MIN	79.56	10.77	86.27	8.34	-2.951	**0.003**	-6.71	2.49	-11.69	-1.73
MAP AT 2 MIN	78.19	9.43	84.53	9.57	-2.684	**0.007**	-6.34	2.45	-11.25	-1.44
MAP AT 3 MIN	76.92	7.92	83.91	9.41	-3.084	**0.002**	-6.99	2.25	-11.48	-2.49
MAP AT 4 MIN	75.92	6.36	84.09	8.47	-3.926	**0.001**	-8.17	1.93	-12.04	-4.30
MAP AT 5 MIN	75.11	5.23	84.04	7.78	-4.452	**0.001**	-8.93	1.71	-12.36	-5.51
MAP AT 6 MIN	74.28	5.00	84.40	7.28	-4.909	**0.001**	-10.12	1.61	-13.35	-6.89
MAP AT 7 MIN	74.18	5.19	84.30	7.33	-4.946	**0.001**	-10.12	1.64	-13.40	-6.84
MAP AT 8 MIN	74.46	5.05	84.43	7.75	-4.732	**0.001**	-9.98	1.69	-13.36	-6.60
MAP AT 9 MIN	74.11	4.93	84.41	8.43	-4.755	**0.001**	-10.30	1.78	-13.87	-6.73
MAP AT 10 MIN	74.63	5.11	84.74	8.17	-4.593	**0.001**	-10.11	1.76	-13.63	-6.59
MAP AT 11 MIN	75.53	4.63	83.72	7.64	-4.170	**0.001**	-8.19	1.63	-11.45	-4.92

MAP AT 12 MIN	75.83	5.23	85.41	7.90	-4.555	**0.001**	-9.58	1.73	-13.04	-6.12
MAP AT 13 MIN	75.80	4.89	85.77	8.01	-4.674	**0.001**	-9.97	1.71	-13.40	-6.54
MAP AT 14 MIN	76.49	5.98	85.68	8.00	-4.201	**0.001**	-9.19	1.82	-12.84	-5.54
MAP AT 15 MIN	76.27	5.70	85.23	7.47	-4.260	**0.001**	-8.97	1.72	-12.40	-5.53
MAP AT 16 MIN	76.64	6.68	84.81	6.97	-3.978	**0.001**	-8.17	1.76	-11.69	-4.64
MAP AT 17 MIN	76.11	5.63	85.17	6.99	-4.481	**0.001**	-9.06	1.64	-12.34	-5.78
MAP AT 18 MIN	76.04	5.72	85.56	5.66	-4.940	**0.001**	-9.51	1.47	-12.45	-6.57
MAP AT 19 MIN	76.47	5.73	84.88	6.11	-4.348	**0.001**	-8.41	1.53	-11.47	-5.35
MAP AT 20 MIN	77.14	6.51	84.46	6.16	-4.016	**0.001**	-7.31	1.64	-10.59	-4.04

MAP remained significantly lower in the Desflurane group as compared to the Sevoflurane group throughout the study period

Figure 15: Trends of mean values of intra-operative Mean arterial pressure (MAP) (mmHg)

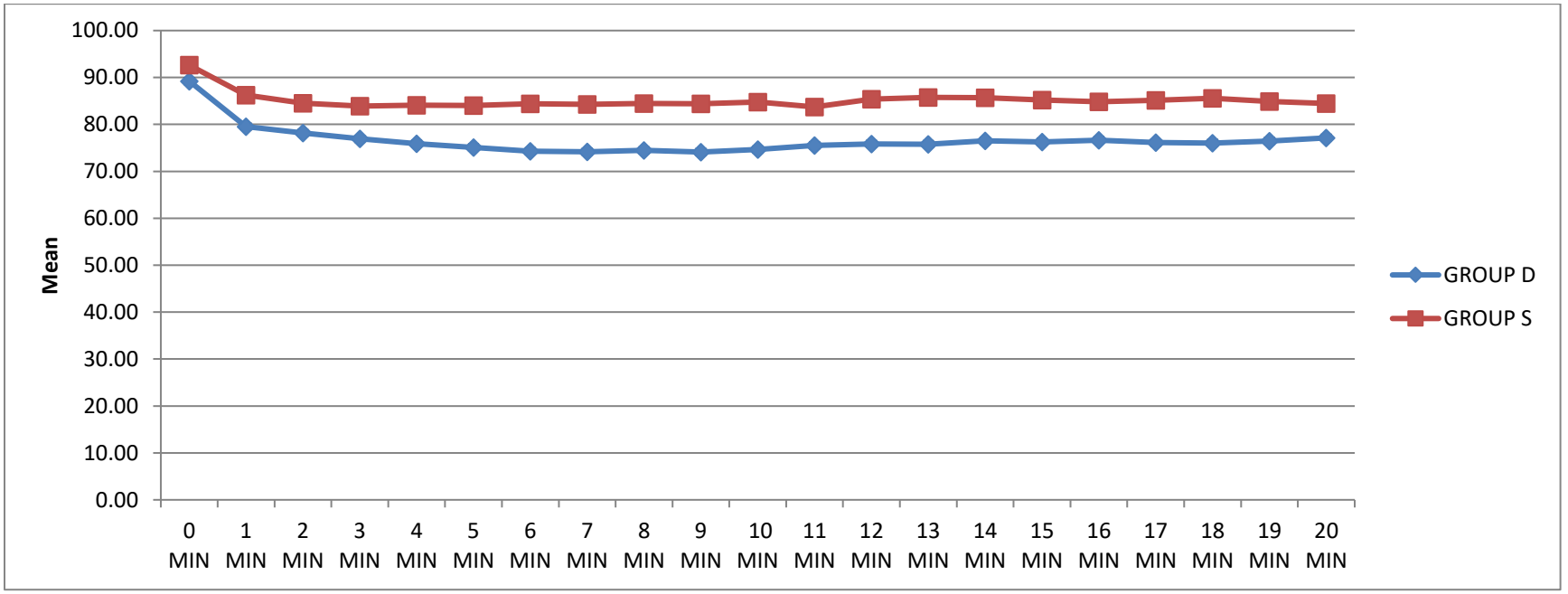


Table 23: Comparison of Mean intraoperative MAP with Baseline in Group D

	GROUP D		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline MAP	89.23	8.50						
Average MAP	76.62	5.01	12.866	**0.001**	12.62	5.37	10.61	14.62

In the Desflurane group, MAP decreased from a baseline value of 89.23mmHg to 76.62mmHg at 1.0 MAC, with a mean difference of 12.62mmHg, which is statistically significant (p-value 0.001)

Table 24: Comparison of Mean intraoperative MAP with Baseline in Group S

	GROUP S		Z	p-value	Difference		95% Confidence Interval of the Difference	
	Mean	SD			Mean	Std. Error	Lower	Upper
Baseline MAP	92.63	10.20						
Average MAP	85.16	6.75	5.322	**0.001**	7.47	7.69	4.60	10.34

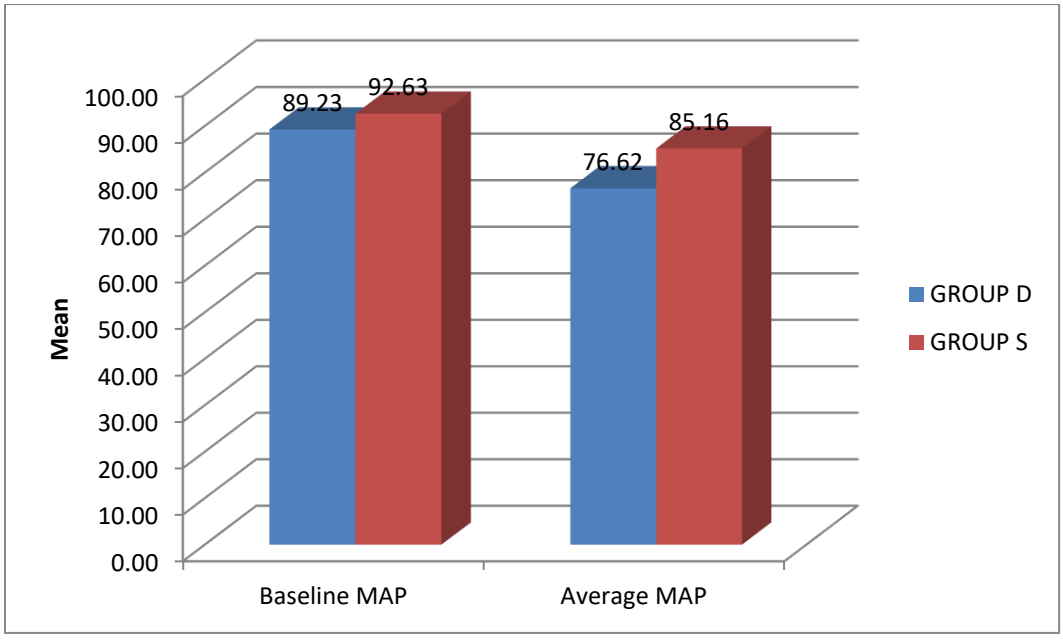
In the Sevoflurane group, MAP decreased from a baseline value of 92.63mmHg to 85.16mmHg at 1.0 MAC, with a mean difference of 7.47mmHg which is statistically significant (p-value 0.001)

Table 25: Comparison of the change in MAP between Desflurane and Sevoflurane groups

	GROUP D		GROUP S	
	Mean	SD	Mean	SD
Baseline MAP	89.23	8.50	92.63	10.20
Average MAP	76.62	5.01	85.16	6.75
Z, P-VALUE	12.866	0.001	5.322	0.001
Difference	12.62	5.37	7.47	7.69
Z, P-VALUE	-3.216		**0.001**	

Both agents caused a significant decrease in MAP from baseline. Desflurane reduced MAP by 12.62mmHg from baseline, whereas Sevoflurane decreased MAP by 7.47mmHg. Change in MAP from baseline is more with Group D as compared to Group S (p-value 0.001)

Figure 16: Relative change of MAP (baseline to average)



DISCUSSION

Inhalational anesthetic agents like Desflurane and Sevoflurane are essential in modern anesthesia due to their rapid induction and recovery times. Their low blood/gas solubility allows for rapid adjustment of anesthetic depth, making them ideal for cases where quick changes in depth are necessary[26]. Both agents are effective for general anesthesia, but further understanding their impact on hemodynamics can help guide the choice of anesthetic agent, especially for patients with specific cardiovascular concerns.

Conventional monitoring methods often focus on macro-hemodynamic parameters such as BP and cardiac output, which do not directly assess microvascular and end-organ perfusion. In hypotension, vital organ perfusion takes priority over the perfusion of other tissue beds, such as the gut and skin. Therefore, monitoring the perfusion of peripheral tissues like the skin could potentially benefit early detection[44].

Peripheral perfusion can be measured using the Perfusion Index (PI), which is calculated from the photoelectric plethysmographic waveform obtained via pulse oximetry. PI is the ratio of the pulsatile component (arterial) and non-pulsatile component of light reaching the detector. Any changes in peripheral perfusion are accompanied by a concurrent change in the pulsatile component[14]. Sympathetic tone is the primary determinant of PI. Peripheral vasodilation results in an increase in PI, while vasoconstriction leads to a decrease in the values. It can be used to monitor changes in vasomotor tone caused by anesthetic drugs, including inhalational agents[45].

The present study aimed to evaluate the effect of Desflurane and Sevoflurane on hemodynamics and peripheral perfusion using PI as a marker on sixty adult patients (18-60 yrs) scheduled for elective surgery under general anesthesia. The primary outcome of our study was PI, and other hemodynamic parameters such as HR, SBP, DBP, and MAP were the secondary outcomes. After induction of anesthesia, all parameters (HR, PI,

SBP, DBP, and MAP) were continuously recorded every minute for 20 minutes at 1.0 MAC.

The primary findings of our study showed that PI was higher in patients receiving Desflurane than in those receiving Sevoflurane, with a mean difference of: 2.44 (p-value <0.001).

Similar findings were reported in a prior study conducted by Ryu et al. involving patients who underwent arthroscopic knee surgery under general anesthesia, comparing the effects of Desflurane and Sevoflurane on peripheral vasodilation by measuring PI. The study demonstrated that the PI remained significantly higher in the Desflurane group than in the Sevoflurane group, both before and after nociceptive stimulation. Specifically, the mean difference in PI was 3.3 (95% CI: 2.0-4.7; p-value<0.001) before stimulation and 2.8 (95% CI: 2.0-3.7; p-value<0.001) after stimulation[21]. Our study did not involve administering a nociceptive stimulus. However, the difference in PI was lower in our study compared to the prestimulus values in the study by Ryu et al. This could be due to the use of opioids and nitrous oxide during induction, unlike in the study by Ryu et al. These agents are known to lower the necessary concentration of inhaled anesthetic required to achieve the desired MAC value.

Our findings regarding PI were consistent with another retrospective study by Oh et al. They compared the effects of Desflurane and Sevoflurane on PI in noncardiac surgery patients among 230 pairs of patients. They observed that the intraoperative PI was significantly higher in the Desflurane group than in the Sevoflurane group, with a median paired difference of 0.45 (95% CI 0.16 to 0.74, p=0.002). Additionally, the duration of PI below thresholds of 1.0 and 1.5 was also significantly longer in the Sevoflurane group [13]. They concluded that peripheral perfusion was better with Desflurane, which can be explained by its more potent vasodilatory properties.

Isoflurane and Desflurane are known to induce tachycardia, particularly at higher concentrations. This is likely due to their airway irritant properties, which can lead to increased sympathetic nervous system activity and elevated plasma catecholamine levels[46]. In contrast, Sevoflurane and Halothane do not typically induce tachycardia. Sevoflurane is less irritating to the airways and does not significantly increase plasma catecholamine levels, which likely explains its minimal effect on HR[46].

Our findings regarding the hemodynamic parameters, such as HR, showed significantly higher values in the Desflurane group as compared to the Sevoflurane group, with a mean difference of 5.69 bpm (p-value 0.011). Several studies have shown that Desflurane is linked to higher HR compared to Sevoflurane. Desflurane is known to cause temporary increases in HR and BP when the inspired concentration is rapidly increased, possibly due to the sympathetic stimulation. This effect is particularly noticeable during the induction of anesthesia and immediately afterward, which may not be suitable for patients at risk of cardiovascular instability. In contrast, Sevoflurane maintains more stable hemodynamics during induction and causes less increase in HR compared to Desflurane[34]. Bedforth et al. found that patients who received Desflurane had significantly higher HR compared to those who received Sevoflurane after anesthesia induction with propofol[33]. Similarly, Lee et al. reported that HR was significantly higher in patients receiving Desflurane than in those receiving Sevoflurane during anesthesia induction and endotracheal intubation[34]. These findings are consistent with the known properties of Desflurane, which include a sympathetic stimulation effect that can lead to increased HR. Furthermore, Muzi et al. observed that rapid increases in the inspired concentration of Desflurane was associated with tachycardia, although the HR increase was not dependent on the rate or concentration of Desflurane. The sympathetic nerve activity responses were directly proportional to the rate of change in Desflurane concentration[32]. In our study, we initiated an inhalational agent after intubation and attempted to

reach the desired MAC value quickly using higher flows. In contrast, the study by Ryu et al. showed no significant difference in HR in both groups (mean difference: 3 bpm; p-value = 0.191)(21). This could be because the data was collected during the final 10 minutes of a 30-minute waiting period after induction and achieving 1.0 MAC, whereas, in our study, we recorded data immediately after induction until 20 minutes.

Another hemodynamic parameter that we studied was non-invasive blood pressure (SBP, DBP, MAP). We found that Desflurane caused a significant decrease in SBP, DBP, and MAP as compared to Sevoflurane (p-value 0.001). Lowe et al. in their study, demonstrated that the decrease in SVR caused by Desflurane was mainly due to the dilation of arteriolar resistance vessels. On the other hand, the decrease in left ventricular afterload induced by Sevoflurane may primarily occur by altering the mechanical properties of the aorta[22]. Ryu et al., in their study, reported that the MAP values in participants who were given Desflurane were consistently lower compared to those who were given Sevoflurane (P=0.026), indicating the potent vasodilatory properties of Desflurane. However, SBP and DBP were not studied as separate parameters in the study by Ryu et al. These findings suggest that Desflurane may lead to more significant peripheral vasodilation than Sevoflurane at equivalent doses[21].

Conversely, in a study by Isik et al., no significant difference in blood pressure was found between Desflurane and Sevoflurane in children aged 5-15 years undergoing low-flow anesthesia. Both agents maintained stable heart rates and MAP without significant adverse effects on renal or hepatic function[47].The study by Oh et al. supports these findings by demonstrating that there was no significant difference in the durations of low MAP between the two groups[13]. This suggests that the impact of Desflurane on BP may vary depending on the clinical context and the dynamics of anesthesia administration.

Despite low blood pressures (SBP, DBP, MAP), PI remained significantly higher in the Desflurane group compared to the Sevoflurane group in our

study. This shows that PI, though dependent on SVR and MAP, is not exclusively determined by it. Similarly, the study by He et al. suggests that MAP may not solely influence PI[42]. The study involved septic shock patients, and varying levels of MAP were induced through norepinephrine titration. Despite significant changes in MAP, the PI did not consistently or significantly change across different MAP levels[42]. This suggests that PI can vary independently of MAP, indicating that factors other than MAP may influence PI values. Another study involving patients undergoing major non-cardiac surgery found that sublingual microcirculation, as assessed by various perfusion measures, was well maintained across a range of intraoperative MAPs from 65 to 120 mmHg, indicating no meaningful association between MAP and sublingual perfusion within this range[48]. These findings indicate that perfusion indices such as PI may stay consistent within certain MAP ranges, even as MAP varies during controlled anesthesia. This suggests that these indices may be independent of MAP in anesthesia settings, possibly due to autoregulatory mechanisms that maintain perfusion at different pressures or specific physiological conditions unique to anesthesia compared to normal awake states.

Since there is limited literature comparing the effects of general anesthetic agents on peripheral perfusion, further research into these complex parameters that can influence patient outcomes is needed. Research indicates that a lower intraoperative PI correlates with a higher risk of severe postoperative complications and mortality in acute high-risk surgical patients. Maintaining adequate perfusion is crucial for improving patient outcome.

There are certain limitations to our study: Even though the temperature of the operation theater was kept between 22 and 26 degrees Celsius, temperature monitoring was not done. Temperature has a significant influence on PI values. Also, movement at the measuring site can affect the measurements. While we made every effort to record PI values accurately

and minimize errors, it's possible that some variations in PI could have occurred due to unavoidable movements.

In conclusion, Desflurane produced higher PI values and lower MAP than Sevoflurane, suggesting greater vasodilating effects. Further research comparing the effects of anesthetic agents on peripheral perfusion and microcirculation can provide valuable insights into this area and how these agents can impact outcomes.

SUMMARY AND CONCLUSION

This prospective study was conducted in the Department of Anaesthesiology, Dayanand Medical College and Hospital, Ludhiana, on 60 adult patients of ASA grade I and II of either gender undergoing surgery under general anesthesia. Patients were assigned to one of the two groups of 30 each according to computer-generated random numbers. The technique of general anesthesia was standardized in both groups. Group D was maintained with Desflurane, and Group S was maintained with Sevoflurane. After achieving 1.0 MAC, all parameters, that is, HR, PI, SBP, DBP, and MAP were continuously recorded every minute for 20 min after induction of general anesthesia and compared in both groups.

The following conclusions were drawn –

1. In participants receiving Desflurane, the perfusion index (PI) values remained higher compared to those receiving Sevoflurane, indicating Desflurane's better perfusion properties.
2. The heart rate also remained higher in the Desflurane group compared to the Sevoflurane group.
3. Additionally, the Desflurane group had lower systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) values compared to the Sevoflurane group, showing greater vasodilation.

Therefore, we conclude that Desflurane resulted in higher PI and HR values, with lower SBP, DBP and MAP, compared to Sevoflurane. The study suggests that Desflurane has a greater vasodilating effect, which may have led to improved perfusion.

BIBLIOGRAPGY

1. Eger EI. New Inhaled Anesthetics. Anesthesiology. 1994;80:906-22.
2. Wissing H, Kuhn I, Rietbrock S, Fuhr U. Pharmacokinetics of inhaled anaesthetics in a clinical setting: comparison of desflurane, Isoflurane and sevoflurane. British Journal of Anaesthesia. 2000;84:443–9.
3. Magni G, Rosa IL, Melillo G, Savio A, Rosa G. A Comparison Between Sevoflurane and Desflurane Anesthesia in Patients Undergoing Craniotomy for Supratentorial Intracranial Surgery. Anesthesia and analgesia. 2009;109:567–71.
4. Mahmoud NA, Rose DJA, Laurence AS. Desflurane or sevoflurane for gynaecological day-case anaesthesia with spontaneous respiration? Anaesthesia. 2001;56:171-4.
5. Kapoor M, Vakamudi M. Desflurane - Revisited. Anaesthesiol Clin Pharmacol.. 2012;28:92-100.
6. Weiskopf RB, Eger Ii EI, Daniel M, Noorani M. Cardiovascular Stimulation Induced by Rapid Increases in Desflurane Concentration in Humans Results from Activation of Tracheopulmonary and Systemic Receptors. Anesthesiology. 1995;83:1173-8.
7. Shelton CL, Sutton R, White SM. Desflurane in modern anaesthetic practice: walking on thin ice(caps)? British Journal of Anaesthesia. 2020;125:852–6.
8. Wesselink EM, Kappen TH, Torn HM, Slooter AJC, Van Klei WA. Intraoperative hypotension and the risk of postoperative adverse outcomes: a systematic review. British Journal of Anaesthesia. 2018;121:706–21.
9. Min JY, Chang HJ, Chu SJ, Chung MY. The Perfusion Index of the Ear as a Predictor of Hypotension Following the Induction of Anesthesia in Patients with Hypertension: A Prospective Observational Study. Journal of Clinical Medicine.. 2022;11:6342.
10. Strait JB, Lakatta EG. Aging-Associated Cardiovascular Changes and Their Relationship to Heart Failure. Heart Fail Clin. 2012;8:143–64.

11. Andrzejewska A, Miegoń J, Zacha S, Skonieczna-Żydecka K, Jarosz K, Zacha W, et al. The Impact of Intraoperative Haemodynamic Monitoring, Prediction of Hypotension and Goal-Directed Therapy on the Outcomes of Patients Treated with Posterior Fusion Due to Adolescent Idiopathic Scoliosis. Journal of Clinical Medicine.. 2023;12:4571.
12. Singhal N, Bansal A, Duggal R. Non - Invasive hemodynamic parameters as predictors for hypotension following spinal anesthesia in parturients undergoing lower segment cesarean section: A prospective observational study. J Obstet Anaesth Crit Care. 2023;13:180-6.
13. Oh C, Lee S, Song BS, Kwon S, Kim YH, Yoon SH, Shin YS, et al. Comparative effects of desflurane and sevoflurane on intraoperative peripheral perfusion index: a retrospective, propensity score matched, cohort study. Scientific Reports. 2023;13:2991.
14. Elshal MM, Hasanin AM, Mostafa M, Gamal RM. Plethysmographic peripheral perfusion index: could it be a new vital sign?. Frontiers in Medicine. 2021 Oct 1;8:651909.
15. Toyama S, Kakumoto M, Morioka M, Matsuoka K, Omatsu H, Tagaito Y, et al. Perfusion index derived from a pulse oximeter can predict the incidence of hypotension during spinal anaesthesia for Caesarean delivery. British Journal of Anaesthesia. 2013;111:235–41.
16. Yeniocak S. Perfusion index analysis in patients presenting to the emergency department due to synthetic cannabinoid use. Medicina. 2019;55:752.
17. Inamanamelluri R, Das S, Senapati LK, Pradhan A. Perfusion index and its correlation with intraoperative hypotension in lower-segment cesarean section under spinal anesthesia: A prospective observational study in a tertiary care hospital in eastern India. Cureus. 2022;14.
18. Lee S, Kim KS, Park SW, You AH, Lee SW, Kim YJ, et al. Correlation between the perfusion index and intraoperative hypothermia: a prospective observational pilot study. Medicina. 2021;57:364.

19. Duggappa DR, Lokesh MP, Dixit A, Paul R, Rao RR, Prabha P. Perfusion index as a predictor of hypotension following spinal anaesthesia in lower segment caesarean section. Indian journal of anaesthesia. 2017;61:649-54.
20. Mehandale SG, Rajasekhar P. Perfusion index as a predictor of hypotension following propofol induction-A prospective observational study. Indian journal of anaesthesia. 2017;61:990-5.
21. Ryu KH, Hwang SH, Shim JG, Ahn JH, Cho EA, Lee SH, et al. Comparison of vasodilatory properties between desflurane and sevoflurane using perfusion index: a randomised controlled trial. British Journal of Anaesthesia. 2020;125:935–42.
22. Lowe D, Hettrick DA, Pagel PS, Warltier DC. Influence of Volatile Anesthetics on Left Ventricular Afterload In Vivo. Anesthesiology. 1996;85:112–20.
23. Eis S, Kramer J. Anesthesia Inhalation Agents and Their Cardiovascular Effects. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
24. Eger 2nd EI. Desflurane animal and human pharmacology: Aspects of kinetics, safety, and MAC. Anesthesia and Analgesia. 1992;75:S3-7.
25. White PF. Studies of desflurane in outpatient anesthesia. Anesthesia and analgesia. 1992;75:S47-53.
26. Young CJ, Apfelbaum JL. Inhalational anesthetics: Desflurane and sevoflurane. J Clin Anesth. 1995;7:564-77.
27. Jakobsson J. Desflurane: A clinical update of a third-generation inhaled anaesthetic. Acta Anaesthesiol Scand. 2012;56:420–32.
28. Behne M, Wilke HJ, Harder S. Clinical Pharmacokinetics of Sevoflurane: Clin Pharmacokinet. 1999;36:13-26.
29. Gentz BA, Malan TP. Renal Toxicity with Sevoflurane: A Storm in a Teacup? Drugs. 2001;61:2155–62.
30. De Hert S, Moerman A. Sevoflurane. F1000Research. 2015;4:626.

31. Rödig G, Keyl C, Wiesner G, Philipp A, Hobbhahn J. Effects of sevoflurane and Isoflurane on systemic vascular resistance: use of cardiopulmonary bypass as a study model. Br J Anaesth. 1996;76:9–12.
32. Muzi M, Lopatka CW, Ebert TJ. Desflurane-mediated Neurocirculatory Activation in Humans. Anesthesiology. 1996;84:1035–42.
33. Bedforth NM, Hardman JG, Nathanson MH. Cerebral hemodynamic response to the introduction of desflurane: A comparison with sevoflurane. Anesthesia & Analgesia. 2000;91:152-5.
34. Lee JW, Kim MK, Kim JY. Hemodynamic responses to 1 MAC desflurane inhalation during anesthesia induction with propofol bolus and remifentanil continuous infusion: a prospective randomized single-blind clinical investigation. BMC Anesthesiol. 2023;23:59.
35. Sakai K, Imaizumi T, Maeda H, Nagata H, Tsukimori K, Takeshita A, et al. Venous distensibility during pregnancy. Comparisons between normal pregnancy and preeclampsia. Hypertension. 1994;24:461–6.
36. Barwin BN, Roddie IC. Venous distensibility during pregnancy determined by graded venous congestion. American journal of obstetrics and gynecology. 1976;125:921–3.
37. Ajne G, Ahlborg G, Wolff K, Nisell H. Contribution of endogenous endothelin-1 to basal vascular tone during normal pregnancy and preeclampsia. American journal of obstetrics and gynecology. 2005;193:234–40.
38. Mowafi HA, Ismail SA, Shafi MA, Al-Ghamdi AA. The Efficacy of Perfusion Index as an Indicator for Intravascular Injection of Epinephrine-Containing Epidural Test Dose in Propofol-Anesthetized Adults. Anesthesia & Analgesia. 2009;108:549–53.
39. Ginosar Y, Weiniger CF, Meroz Y, Kurz V, Bdolah-Abram T, Babchenko A, et al. Pulse oximeter perfusion index as an early indicator of sympathectomy after epidural anesthesia. Acta anaesthesiologica scandinavica. 2009;53:1018–26.

40. Surekha C, Eadara V, Satish Kumar M. Evaluation of perfusion index as an objective tool to assess analgesia during laparoscopic surgeries under general anaesthesia. Indian Journal of Anaesthesia. 2022;66:260-65.
41. Chu CL, Huang YY, Chen YH, Lai LP, Yeh HM. An observational study: The utility of perfusion index as a discharge criterion for pain assessment in the postanesthesia care unit. PloS one. 2018;13:e0197630.
42. He HW, Liu WL, Zhou X, Long Y, Liu DW. Effect of mean arterial pressure change by norepinephrine on peripheral perfusion index in septic shock patients after early resuscitation. Chinese Medical Journal. 2020;133:2146–52.
43. Ajayan N, Christudas J, Morris L, Mathew O, Hrishi AP. A Perfusion Index-Based Evaluation and Comparison of Peripheral Perfusion in Sevoflurane and Isoflurane Anaesthesia: A Prospective Randomised Controlled Trial. Turkish Journal of Anaesthesiology and Reanimation. 2023;51:97-104.
44. Hasanin A, Mukhtar A, Nassar H. Perfusion indices revisited. Journal of intensive care. 2017;5:24.
45. Coutrot M, Dudoignon E, Joachim J, Gayat E, Vallée F, Dépret F. Perfusion index: Physical principles, physiological meanings and clinical implications in anaesthesia and critical care. Anaesthesia Critical Care & Pain Medicine. 2021;40:100964.
46. Young CJ, Apfelbaum JL. Inhalational anesthetics: Desflurane and sevoflurane. Journal of clinical anesthesia. 1995;7:564–77.
47. Isik Y, Goksu S, Kocoglu H, Oner U. Low flow desflurane and sevoflurane anaesthesia in children. European journal of anaesthesiology. 2006;23:60-4.
48. Laou E, Papagiannakis N, Michou A, Ntalarizou N, Ragias D, Angelopoulou Z, et al. Association between mean arterial pressure and

sublingual microcirculation during major non-cardiac surgery: Post hoc analysis of a prospective cohort. Microcirculation. 2023;30:e12804.

Sr No	MRD No.	Sex	GROUP(D/S)	Pt Initials	AGE(YEARS)	ASA	BS PR	HR 1 MIN	HR 2 MIN	HR 3 MIN	HR 4 MIN	HR 5 MIN	HR 6 MIN	HR 7 MIN	HR 8 MIN	HR 9 MIN	HR 10 MIN	HR 11 MIN	HR 12 MIN	HR 13 MIN	HR 14 MIN	HR 15 MIN	HR 16 MIN
1	950443	M	S	SP	32	1	67	89	82	82	80	82	81	84	82	80	81	80	79	84	83	82	80
2	1447365	F	S	NS	18	1	96	100	100	99	98	97	96	95	99	100	98	99	100	96	95	97	98
3	1435648	F	S	SS	22	2	86	84	81	82	80	79	77	78	77	81	82	80	80	79	77	75	74
4	1462715	M	S	A	22	1	78	137	123	124	125	122	120	110	108	100	91	92	90	89	89	81	85
5	1442067	M	S	AS	59	2	99	72	70	73	74	80	81	82	79	83	80	82	81	86	79	76	80
6	1465195	M	D	AS	23	1	90	105	104	104	100	97	96	93	89	88	89	87	88	90	89	86	88
7	1240195	F	D	MM	33	1	70	79	92	91	100	95	85	78	76	74	75	72	76	77	78	74	69
8	1468676	M	D	MS	32	1	96	92	102	108	102	99	95	94	88	87	88	87	87	88	94	88	87
9	1465477	F	D	RR	34	2	78	100	95	87	88	85	78	80	79	78	75	76	75	77	78	82	80
10	1464857	M	D	NKS	58	1	85	98	97	93	90	90	90	88	86	84	83	80	80	79	80	79	77
11	1473414	M	D	RA	33	2	75	85	82	90	80	92	79	78	78	77	78	76	70	72	80	82	85
12	1349887	F	S	NG	35	1	89	96	98	100	99	95	99	93	97	92	99	90	98	92	97	96	94
13	1528415	F	S	RK	33	2	82	86	99	100	96	95	92	85	82	81	80	80	82	83	81	84	86
14	802484	F	S	JR	32	1	85	97	96	96	95	94	96	90	87	86	88	82	88	92	93	93	90
15	1398466	M	S	GS	24	2	81	99	98	98	97	97	97	95	96	92	90	90	88	89	91	90	90
16	1548660	M	D	S	27	2	70	90	92	90	89	88	87	89	88	88	90	92	89	85	82	88	86
17	1555465	M	S	R	27	1	72	82	85	88	85	80	79	78	77	70	72	75	80	82	75	76	77
18	1550989	M	S	GS	25	1	68	66	62	60	58	69	70	61	60	63	64	60	60	64	70	72	73
19	1540001	M	S	KS	57	2	82	79	78	82	79	78	77	76	75	70	71	85	88	86	82	80	78
20	1417076	F	S	RR	33	1	72	79	80	85	90	88	86	92	95	90	84	80	78	79	80	82	84
21	1489867	M	S	A	23	1	72	85	80	77	78	79	77	76	76	75	70	74	72	72	71	70	69
22	1568237	F	S	H	35	2	76	89	90	90	91	91	89	88	90	92	94	94	92	92	90	90	88
23	1568533	F	D	RK	24	1	65	89	90	85	82	80	79	77	78	80	82	81	80	80	81	85	84
24	1579474	F	S	TK	45	2	83	99	100	101	99	95	92	90	89	91	92	92	93	94	89	90	90
25	1583543	F	S	K	43	1	68	80	74	68	66	65	70	74	72	70	71	72	80	82	81	79	75
26	1581582	F	S	KD	56	2	64	80	82	85	75	77	76	76	72	70	75	80	79	79	78	77	76
27	1571944	F	D	BS	37	2	88	79	78	75	70	70	72	73	74	81	76	75	77	73	74	70	71
28	1583136	F	D	SK	41	1	80	81	90	99	98	98	99	101	102	103	95	99	98	97	96	91	89
29	1586282	F	D	GK	46	2	74	99	98	92	91	91	90	90	89	88	95	99	98	104	100	92	91
30	1587268	M	D	DS	22	1	72	84	89	88	90	92	91	94	93	90	96	89	88	87	86	85	85
31	1587954	F	S	RD	48	1	72	72	70	71	72	73	80	84	88	81	80	77	76	76	77	75	70
32	236636	M	S	GS	44	2	80	99	92	91	85	86	87	88	80	85	86	90	91	91	92	89	88
33	797257	F	D	RK	39	2	89	101	100	102	99	98	97	99	99	99	100	100	101	104	110	99	99
34	7727	F	D	MK	39	2	65	88	89	90	91	91	92	93	90	91	91	89	88	93	93	90	91
35	1582991	F	D	JK	60	2	74	80	82	81	77	75	88	89	90	92	92	94	95	99	100	99	103
36	1587603	F	D	GK	32	1	86	93	90	89	95	94	99	99	101	102	100	99	105	99	97	97	98
37	1588934	F	S	SS	24	2	108	100	98	95	90	88	89	92	90	87	88	89	89	88	90	91	91
38	1588817	F	S	AK	32	1	120	119	115	113	110	109	108	100	105	111	109	110	112	113	111	108	107
39	1589332	F	D	B	35	1	82	85	99	100	104	105	109	110	104	102	101	107	110	104	99	98	104
40	1585586	F	D	MK	29	1	79	85	88	89	90	91	92	95	96	100	104	103	101	100	98	99	104
41	1586846	M	D	LK	49	1	78	91	95	99	98	98	101	102	100	104	103	103	105	106	102	99	99
42	1589267	F	S	AK	40	2	78	81	75	77	72	70	69	74	75	75	80	81	82	82	78	77	76
43	1588558	F	D	RC	29	1	69	85	88	90	95	99	99	101	102	97	98	95	100	100	98	99	105
44	1600216	F	D	I	34	1	68	89	92	91	95	99	100	98	94	95	96	100	101	104	99	98	97
45	1599292	F	D	DS	27	1	78	95	99	94	92	90	88	89	95	94	99	100	101	104	102	100	99
46	1602534	M	D	JK	23	1	70	72	84	88	90	92	91	91	95	90	89	88	92	85	89	88	87
47	430731	F	S	M	39	1	89	84	80	82	80	79	78	80	82	83	80	81	79	77	76	78	76
48	1602972	F	D	AK	32	1	92	100	104	103	102	100	96	95	95	94	92	90	90	94	92	91	90
49	1514721	M	S	PS	20	1	68	77	80	81	79	74	73	72	70	69	71	72	74	70	73	73	72
50	1605081	M	S	VS	36	1	82	88	84	82	80	81	79	79	84	85	88	84	89	90	94	91	92
51	1607040	M	S	KP	20	1	71	70	75	77	80	84	83	89	90	91	92	67	68	69	75	70	70
52	1606137	M	D	GS	32	1	67	79	78	80	82	88	92	100	104	102	101	100	99	101	104	101	100

Sr No	MRD No.	Sex	GROUP(D/S)	HR 17 MIN	HR 18 MIN	HR 19 MIN	HR 20 MIN	AV HR	BS SBP	SBP 1 MIN	SBP 2 MIN	SBP 3 MIN	SBP 4 MIN	SBP 5 MIN	SBP 6 MIN	SBP 7 MIN	SBP 8 MIN	SBP 9 MIN	SBP 10 MIN	SBP 11 MIN	SBP 12 MIN
1	950443	M	S	79	80	81	81	80.90	110	111	102	98	97	96	106	105	104	106	106	106	102
2	1447365	F	S	99	100	97	98	97.95	140	104	93	92	103	101	98	102	98	101	96	90	93
3	1435648	F	S	78	80	81	82	79.67	110	100	97	96	94	94	96	97	94	95	99	94	95
4	1462715	M	S	85	85	86	84	100.19	110	139	110	92	95	98	100	105	106	110	110	120	128
5	1442067	M	S	81	81	82	82	80.14	140	95	100	100	97	110	108	107	105	112	105	111	109
6	1465195	M	D	89	90	87	88	92.24	130	144	141	146	141	132	126	121	121	119	120	121	120
7	1240195	F	D	70	72	70	68	78.14	110	115	99	100	102	102	99	99	97	96	97	95	99
8	1468676	M	D	89	90	89	88	92.29	110	143	141	136	104	100	98	100	100	101	109	108	107
9	1465477	F	D	79	75	77	82	81.14	110	146	128	111	107	104	104	108	108	105	110	111	120
10	1464857	M	D	78	77	89	81	84.95	110	111	108	102	100	102	99	97	99	104	102	103	101
11	1473414	M	D	90	92	88	82	81.48	140	120	123	121	116	106	108	105	109	108	105	116	112
12	1349887	F	S	95	93	92	89	94.90	110	106	100	101	99	105	100	102	107	101	101	112	104
13	1528415	F	S	88	87	90	91	87.14	130	126	121	129	117	115	114	106	102	100	106	104	116
14	802484	F	S	90	91	92	94	91.19	118	114	112	109	100	107	113	112	111	105	118	119	115
15	1398466	M	S	91	90	92	91	92.48	120	109	108	112	111	108	107	113	116	109	107	106	114
16	1548660	M	D	92	88	89	91	87.76	125	109	109	108	104	103	106	100	101	99	103	103	106
17	1555465	M	S	79	85	90	88	79.76	110	102	109	111	107	116	116	118	120	108	121	105	101
18	1550989	M	S	69	72	70	71	65.81	112	106	116	112	110	109	112	105	109	101	98	99	109
19	1540001	M	S	79	82	88	90	80.24	130	104	103	104	112	122	122	128	129	116	120	126	130
20	1417076	F	S	85	87	90	88	84.48	116	109	108	105	109	105	110	115	120	122	117	108	109
21	1489867	M	S	70	71	72	70	74.10	130	122	120	125	130	129	128	124	120	119	119	118	117
22	1568237	F	S	86	87	88	88	89.29	110	106	102	102	101	101	108	108	107	106	106	108	109
23	1568533	F	D	83	86	84	82	81.57	130	105	110	108	106	98	102	101	105	110	107	106	109
24	1579474	F	S	94	95	92	93	93.00	130	120	121	118	117	117	110	112	115	114	116	118	119
25	1583543	F	S	74	74	74	70	73.29	110	109	104	106	100	98	99	98	97	97	105	109	109
26	1581582	F	S	74	71	79	74	76.14	120	131	132	124	129	122	120	121	125	119	119	118	114
27	1571944	F	D	71	73	73	74	74.62	120	102	101	99	98	105	111	95	94	93	90	94	93
28	1583136	F	D	89	88	87	88	93.71	135	107	105	111	112	115	114	105	104	103	102	110	109
29	1586282	F	D	90	96	97	99	93.48	140	112	115	109	108	107	106	105	106	115	114	112	100
30	1587268	M	D	90	88	87	88	88.19	102	89	90	92	91	90	85	88	87	92	85	84	88
31	1587954	F	S	74	74	73	70	75.48	135	120	121	121	118	117	116	115	120	120	121	122	125
32	236636	M	S	89	90	90	89	88.48	130	120	122	120	118	117	116	110	122	119	117	115	119
33	797257	F	D	95	92	91	90	98.29	130	105	109	111	105	104	103	111	110	111	109	105	98
34	7727	F	D	92	90	90	89	89.33	110	88	90	91	85	84	84	80	92	93	94	95	94
35	1582991	F	D	101	102	98	99	90.95	110	102	101	98	98	97	96	96	97	92	93	95	92
36	1587603	F	D	95	94	93	98	96.33	110	88	89	91	92	90	89	95	94	87	84	83	84
37	1588934	F	S	87	86	85	84	90.71	110	105	108	110	111	115	118	120	117	121	125	113	117
38	1588817	F	S	105	104	108	107	109.71	130	120	122	125	126	120	115	122	115	121	124	118	121
39	1589332	F	D	103	102	100	103	101.48	115	100	95	92	90	89	91	85	86	90	91	88	93
40	1585586	F	D	101	99	103	101	96.10	121	99	98	95	94	93	94	100	101	98	92	90	94
41	1586846	M	D	104	102	102	104	99.76	110	92	90	89	88	91	92	93	89	90	91	90	90
42	1589267	F	S	75	75	70	72	75.90	135	122	125	129	125	130	131	124	122	120	126	124	122
43	1588558	F	D	101	100	97	95	95.86	105	88	82	81	85	89	88	90	82	84	80	84	82
44	1600216	F	D	90	88	94	92	94.29	110	88	87	92	89	86	81	84	82	86	84	82	84
45	1599292	F	D	101	97	96	95	95.62	120	92	90	92	93	92	90	88	95	96	99	98	100
46	1602534	M	D	90	92	91	91	87.86	110	85	88	90	87	88	85	90	91	87	85	89	88
47	430731	F	S	80	81	82	82	80.43	130	125	122	121	120	125	115	122	124	120	122	119	125
48	1602972	F	D	94	92	90	89	94.52	140	111	108	112	115	110	122	114	115	115	120	109	113
49	1514721	M	S	70	71	72	70	72.90	115	112	109	107	107	105	109	110	111	108	107	105	104
50	1605081	M	S	93	90	89	90	86.38	100	105	110	112	112	115	120	121	121	109	108	107	111
51	1607040	M	S	72	78	79	80	77.62	113	112	115	120	110	112	104	102	101	105	104	110	112
52	1606137	M	D	98	99	102	101	94.19	113	90	91	94	92	94	90	85	84	83	82	89	84

Sr No	MRD No.	Sex	GROUP(D/S)	SBP 13 MIN	SBP 14 MIN	SBP 15 MIN	SBP 16 MIN	SBP 17 MIN	SBP 18 MIN	SBP 19 MIN	SBP 20 MIN	AV SBP	BS DBP	DBP1 MIN	DBP 2 MIN	DBP 3 MIN	DBP 4 MIN	DBP 5 MIN	DBP 6 MIN	DBP 7 MIN
1	950443	M	S	104	102	99	96	99	99	104	106	102.76	80	67	62	60	60	65	61	66
2	1447365	F	S	100	102	105	108	107	110	103	102	102.29	90	70	50	52	71	70	68	69
3	1435648	F	S	93	94	94	99	99	104	108	99	97.67	70	63	60	58	57	57	59	57
4	1462715	M	S	128	125	121	119	119	120	128	125	114.67	70	60	54	51	52	56	60	60
5	1442067	M	S	112	108	111	110	107	109	105	102	107.76	90	69	70	71	75	70	68	62
6	1465195	M	D	122	120	119	118	117	121	118	122	125.67	90	78	82	79	65	59	55	52
7	1240195	F	D	102	101	101	105	105	106	108	109	102.24	70	65	60	58	65	59	58	58
8	1468676	M	D	107	120	120	125	122	130	130	127	116.10	70	84	77	63	58	53	54	49
9	1465477	F	D	110	125	120	117	125	109	117	121	115.05	70	94	78	63	59	55	54	61
10	1464857	M	D	101	100	101	108	103	110	111	118	104.29	70	65	55	41	55	58	55	55
11	1473414	M	D	109	112	108	125	107	112	111	109	113.43	90	81	88	80	78	79	70	71
12	1349887	F	S	98	102	110	102	109	104	106	110	104.24	70	73	70	72	68	62	66	64
13	1528415	F	S	114	120	126	122	127	122	120	119	116.95	90	82	81	76	69	68	71	70
14	802484	F	S	121	122	116	117	119	109	111	112	113.33	82	82	79	80	70	72	78	76
15	1398466	M	S	114	107	112	111	109	111	113	109	110.76	84	72	72	70	69	71	74	70
16	1548660	M	D	107	112	110	111	109	107	100	100	106.29	80	69	67	68	65	66	65	64
17	1555465	M	S	116	106	112	101	102	115	112	106	110.19	71	65	68	72	68	72	70	75
18	1550989	M	S	105	116	108	108	116	112	109	121	109.19	68	71	72	68	68	65	71	65
19	1540001	M	S	124	129	108	109	116	106	106	105	116.62	92	68	62	63	70	68	68	69
20	1417076	F	S	110	109	102	101	108	109	110	109	110.05	72	68	63	61	72	72	68	69
21	1489867	M	S	117	118	119	119	120	121	120	121	121.71	95	88	89	85	84	85	86	85
22	1568237	F	S	110	112	113	112	110	109	109	108	107.48	70	62	65	66	67	68	67	67
23	1568533	F	D	101	98	99	99	106	105	105	104	105.43	84	70	64	68	65	70	69	62
24	1579474	F	S	121	119	117	116	119	114	112	111	116.95	80	80	79	81	79	80	85	79
25	1583543	F	S	110	112	114	116	117	110	101	102	105.86	70	65	66	69	71	70	69	69
26	1581582	F	S	112	111	115	118	114	112	111	111	118.95	80	82	80	79	77	75	78	76
27	1571944	F	D	95	96	93	95	100	104	105	101	99.24	80	65	64	66	68	64	62	64
28	1583136	F	D	109	108	107	106	112	114	115	117	110.48	75	63	64	60	63	60	61	65
29	1586282	F	D	105	120	118	117	112	101	102	101	110.71	70	62	65	64	69	70	71	70
30	1587268	M	D	90	91	90	92	90	89	88	89	89.62	68	62	61	60	59	61	62	59
31	1587954	F	S	129	124	122	120	125	120	118	119	121.33	88	82	79	78	77	76	72	74
32	236636	M	S	110	115	109	108	115	112	117	119	116.67	85	79	82	81	80	80	79	79
33	797257	F	D	99	98	99	101	120	119	115	112	108.29	85	69	70	71	65	66	65	70
34	7727	F	D	99	100	101	95	96	91	91	90	92.52	70	66	62	63	64	64	67	69
35	1582991	F	D	91	94	93	91	90	88	87	89	94.76	70	71	70	67	69	67	65	68
36	1587603	F	D	90	91	92	93	90	96	97	89	91.14	70	62	60	60	63	60	62	58
37	1588934	F	S	122	114	124	115	110	119	120	116	115.71	72	67	65	66	68	64	68	65
38	1588817	F	S	120	114	116	122	114	118	110	117	119.52	80	82	78	75	78	71	79	81
39	1589332	F	D	97	95	90	92	98	99	86	92	93.05	72	68	63	67	62	69	60	59
40	1585586	F	D	100	99	97	96	104	94	93	90	97.24	85	62	64	65	67	71	70	67
41	1586846	M	D	88	87	89	92	91	87	88	92	90.90	70	64	64	67	60	62	59	60
42	1589267	F	S	128	130	123	124	125	126	120	127	125.62	89	86	89	84	82	79	78	85
43	1588558	F	D	84	89	88	81	82	83	84	83	85.43	72	60	64	67	59	60	62	65
44	1600216	F	D	80	85	82	85	89	87	90	92	86.90	70	59	58	60	67	63	65	60
45	1599292	F	D	101	88	90	92	93	90	101	102	95.33	70	55	59	62	61	58	58	64
46	1602534	M	D	90	87	88	91	92	93	90	88	89.62	60	55	61	59	55	59	60	62
47	430731	F	S	126	127	125	122	129	122	119	124	123.05	80	79	76	75	78	80	82	77
48	1602972	F	D	112	113	109	115	111	118	120	121	115.38	90	78	74	70	74	69	65	71
49	1514721	M	S	109	110	112	114	115	116	120	121	110.76	63	64	63	62	60	59	58	59
50	1605081	M	S	112	108	107	109	110	113	115	117	111.52	60	62	60	63	64	62	60	59
51	1607040	M	S	114	115	120	121	122	119	115	120	112.67	63	60	62	61	62	70	64	68
52	1606137	M	D	88	90	93	92	90	88	86	85	89.67	72	62	60	64	63	60	59	60

Sr No	MRD No.	Sex	GROUP(D/S)	DBP 8 MIN	DBP 9 MIN	DBP 10 MIN	DBP 11 MIN	DBP 12 MIN	DBP 13 MIN	DBP 14 MIN	DBP 15 MIN	DBP 16 MIN	DBP 17 MIN	DBP 18 MIN	DBP 19 MIN	DBP 20 MIN	AV DBP	BS MAP	MAP 1 MIN
1	950443	M	S	60	60	62	65	63	66	63	63	64	63	65	66	60	63.86	90.0	81.7
2	1447365	F	S	70	70	68	65	67	60	61	67	68	65	67	68	68	66.86	106.7	81.3
3	1435648	F	S	56	57	56	56	57	57	55	55	56	56	71	78	57	59.43	83.3	75.3
4	1462715	M	S	65	65	70	72	71	73	75	74	72	75	75	71	70	66.24	83.3	86.3
5	1442067	M	S	60	62	60	60	62	61	71	62	60	61	62	61	69	66.00	106.7	77.7
6	1465195	M	D	52	53	52	52	52	51	52	53	54	58	52	56	51	59.43	103.3	100.0
7	1240195	F	D	56	57	56	60	61	62	65	70	61	61	60	61	60	61.10	83.3	81.7
8	1468676	M	D	60	59	59	59	59	58	61	61	62	60	56	56	52	60.48	83.3	103.7
9	1465477	F	D	62	63	65	65	70	70	76	70	71	68	60	65	80	67.57	83.3	111.3
10	1464857	M	D	58	62	62	63	62	63	66	64	62	63	68	70	74	61.48	83.3	80.3
11	1473414	M	D	67	62	68	70	73	70	72	65	81	73	75	72	69	74.00	106.7	94.0
12	1349887	F	S	72	68	69	68	72	69	74	70	74	75	71	70	68	69.76	83.3	84.0
13	1528415	F	S	68	62	61	63	72	70	81	82	81	78	69	65	68	72.71	103.3	96.7
14	802484	F	S	72	79	82	81	79	81	85	80	79	77	75	74	71	77.81	94.0	92.7
15	1398466	M	S	59	71	72	68	71	72	68	74	73	64	69	66	65	70.19	96.0	84.3
16	1548660	M	D	59	60	62	64	70	59	62	60	59	58	58	59	60	63.52	95.0	82.3
17	1555465	M	S	72	68	70	72	70	68	71	69	68	70	68	67	62	69.33	84.0	77.3
18	1550989	M	S	68	63	69	62	69	62	72	70	70	72	70	70	69	68.29	82.7	82.7
19	1540001	M	S	75	74	79	72	85	82	86	70	72	71	72	71	72	73.38	104.7	80.0
20	1417076	F	S	81	86	85	72	73	72	63	64	68	71	72	69	72	71.10	86.7	81.7
21	1489867	M	S	87	87	87	85	85	84	83	82	86	87	87	86	85	86.10	106.7	99.3
22	1568237	F	S	66	64	64	65	65	70	68	68	69	69	67	67	68	66.76	83.3	76.7
23	1568533	F	D	68	68	65	64	70	70	69	65	68	62	63	63	65	67.24	99.3	81.7
24	1579474	F	S	78	79	80	75	78	75	75	79	78	80	81	79	79	79.00	96.7	93.3
25	1583543	F	S	70	71	62	66	64	65	62	63	64	64	68	64	69	66.71	83.3	79.7
26	1581582	F	S	80	77	75	75	74	77	78	69	74	74	75	78	76	76.62	93.3	98.3
27	1571944	F	D	69	68	71	73	65	64	70	71	65	64	68	66	63	67.14	93.3	77.3
28	1583136	F	D	66	63	61	70	71	72	71	75	75	68	69	70	72	67.33	95.0	77.7
29	1586282	F	D	65	62	63	60	64	67	64	70	71	69	71	75	72	67.33	93.3	78.7
30	1587268	M	D	58	59	61	62	59	60	60	61	60	62	60	61	59	60.67	79.3	71.0
31	1587954	F	S	68	69	68	69	70	71	69	68	68	70	69	65	67	72.24	103.7	94.7
32	236636	M	S	75	79	78	77	77	80	72	75	71	70	75	77	75	77.43	100.0	92.7
33	797257	F	D	71	70	69	65	63	64	60	62	62	60	65	62	65	66.62	100.0	81.0
34	7727	F	D	67	65	68	64	68	67	70	69	62	60	62	62	64	65.38	83.3	73.3
35	1582991	F	D	68	65	66	67	68	70	72	71	60	61	62	62	60	66.62	83.3	81.3
36	1587603	F	D	59	59	60	62	64	60	58	61	62	64	55	52	60	60.52	83.3	70.7
37	1588934	F	S	69	71	72	69	71	78	75	76	70	75	78	75	70	70.67	84.7	79.7
38	1588817	F	S	72	80	75	79	78	81	74	80	81	75	74	70	74	77.00	96.7	94.7
39	1589332	F	D	58	60	59	63	64	66	62	59	58	62	60	65	67	63.00	86.3	78.7
40	1585586	F	D	65	64	65	67	65	67	59	62	64	68	71	69	73	67.14	97.0	74.3
41	1586846	M	D	59	58	60	61	62	60	59	56	64	59	60	61	63	61.33	83.3	73.3
42	1589267	F	S	82	84	76	74	79	75	77	84	82	80	79	83	80	81.29	104.3	98.0
43	1588558	F	D	62	62	65	70	64	62	60	61	67	61	62	62	60	63.19	83.0	69.3
44	1600216	F	D	63	59	60	66	62	64	63	60	65	62	67	70	67	63.33	83.3	68.7
45	1599292	F	D	67	65	68	66	60	64	62	61	64	62	64	60	59	62.33	86.7	67.3
46	1602534	M	D	57	59	62	60	64	61	62	69	62	60	61	64	66	60.86	76.7	65.0
47	430731	F	S	79	82	80	83	81	80	81	79	79	74	76	79	81	79.10	96.7	94.3
48	1602972	F	D	72	71	72	74	70	69	68	73	69	70	69	71	72	71.95	106.7	89.0
49	1514721	M	S	59	55	57	54	54	50	52	55	56	57	59	60	61	57.95	80.3	80.0
50	1605081	M	S	58	60	62	64	70	69	69	68	67	62	64	60	60	63.00	73.3	76.3
51	1607040	M	S	69	63	64	60	63	69	70	65	60	59	62	61	65	63.81	79.7	77.3
52	1606137	M	D	65	61	62	64	61	59	60	59	54	55	56	58	62	60.76	85.7	71.3

Sr No	MRD No.	Sex	GROUP(D/S)	MAP 2 MIN	MAP 3 MIN	MAP 4 MIN	MAP 5 MIN	MAP 6 MIN	MAP 7 MIN	MAP 8 MIN	MAP 9 MIN	MAP 10 MIN	MAP 11 MIN	MAP 12 MIN	MAP 13	MAP 14	MAP 15	MAP 16	MAP 17	MAP 18	MAP 19	MAP 20	AV MAP
1	950443	M	S	75.3	72.7	72.3	75.3	76.0	79.0	74.7	75.3	76.7	78.7	76.0	78.7	76.0	75.0	74.7	75.0	76.3	78.7	75.3	76.83
2	1447365	F	S	64.3	65.3	81.7	80.3	78.0	80.0	79.3	80.3	77.3	73.3	75.7	73.3	74.7	79.7	81.3	79.0	81.3	79.7	79.3	78.67
3	1435648	F	S	72.3	70.7	69.3	69.3	71.3	70.3	68.7	69.7	70.3	68.7	69.7	69.0	68.0	68.0	70.3	70.3	82.0	88.0	71.0	72.17
4	1462715	M	S	72.7	64.7	66.3	70.0	73.3	75.0	78.7	80.0	83.3	88.0	90.0	91.3	91.7	89.7	87.7	89.7	90.0	90.0	88.3	82.38
5	1442067	M	S	80.0	80.7	82.3	83.3	81.3	77.0	75.0	78.7	75.0	77.0	77.7	78.0	83.3	78.3	76.7	76.3	77.7	75.7	80.0	79.92
6	1465195	M	D	101.7	101.3	90.3	83.3	78.7	75.0	75.0	75.0	74.7	75.0	74.7	74.7	74.7	75.0	75.3	77.7	75.0	76.7	74.7	81.51
7	1240195	F	D	73.0	72.0	77.3	73.3	71.7	71.7	69.7	70.0	69.7	71.7	73.7	75.3	77.0	80.3	75.7	75.7	75.3	76.7	76.3	74.81
8	1468676	M	D	98.3	87.3	73.3	68.7	68.7	66.0	73.3	73.0	75.7	75.3	75.0	74.3	80.7	80.7	83.0	80.7	80.7	80.7	77.0	79.02
9	1465477	F	D	94.7	79.0	75.0	71.3	70.7	76.7	77.3	77.0	80.0	80.3	86.7	83.3	92.3	86.7	86.3	87.0	76.3	82.3	93.7	83.40
10	1464857	M	D	72.7	61.3	70.0	72.7	69.7	69.0	71.7	76.0	75.3	76.3	75.0	75.7	77.3	76.3	77.3	76.3	82.0	83.7	88.7	75.75
11	1473414	M	D	99.7	93.7	90.7	88.0	82.7	82.3	81.0	77.3	80.3	85.3	86.0	83.0	85.3	79.3	95.7	84.3	87.3	85.0	82.3	87.14
12	1349887	F	S	80.0	81.7	78.3	76.3	77.3	76.7	83.7	79.0	79.7	82.7	82.7	78.7	83.3	83.3	83.3	86.3	82.0	82.0	82.0	81.25
13	1528415	F	S	94.3	93.7	85.0	83.7	85.3	82.0	79.3	74.7	76.0	76.7	86.7	84.7	94.0	96.7	94.7	94.3	86.7	83.3	85.0	87.46
14	802484	F	S	90.0	89.7	80.0	83.7	89.7	88.0	85.0	87.7	94.0	93.7	91.0	94.3	97.3	92.0	91.7	91.0	86.3	86.3	84.7	89.65
15	1398466	M	S	84.0	84.0	83.0	83.3	85.0	84.3	78.0	83.7	83.7	80.7	85.3	86.0	81.0	86.7	85.7	79.0	83.0	81.7	79.7	83.71
16	1548660	M	D	81.0	81.3	78.0	78.3	78.7	76.0	73.0	73.0	75.7	77.0	82.0	75.0	78.7	76.7	76.3	75.0	74.3	72.7	73.3	77.78
17	1555465	M	S	81.7	85.0	81.0	86.7	85.3	89.3	88.0	81.3	87.0	83.0	80.3	84.0	82.7	83.3	79.0	80.7	83.7	82.0	76.7	82.95
18	1550989	M	S	86.7	82.7	82.0	79.7	84.7	78.3	81.7	75.7	78.7	74.3	82.3	76.3	86.7	82.7	82.7	86.7	84.0	83.0	86.3	81.92
19	1540001	M	S	75.7	76.7	84.0	86.0	86.0	88.7	93.0	88.0	92.7	90.0	100.0	96.0	100.3	82.7	84.3	86.0	83.3	82.7	83.0	87.79
20	1417076	F	S	78.0	75.7	84.3	83.0	82.0	84.3	94.0	98.0	95.7	84.0	85.0	84.7	78.3	76.7	79.0	83.3	84.3	82.7	84.3	84.08
21	1489867	M	S	99.3	98.3	99.3	99.7	100.0	98.0	98.0	97.7	97.7	96.0	95.7	95.0	94.7	94.3	97.0	98.0	98.3	97.3	97.0	97.97
22	1568237	F	S	77.3	78.0	78.3	79.0	80.7	80.7	79.7	78.0	78.0	79.3	79.7	83.3	82.7	83.0	83.3	82.7	81.0	81.0	81.3	80.33
23	1568533	F	D	79.3	81.3	78.7	79.3	80.0	75.0	80.3	82.0	79.0	78.0	83.0	80.3	78.7	76.3	78.3	76.7	77.0	77.0	78.0	79.97
24	1579474	F	S	93.0	93.3	91.7	92.3	93.3	90.0	90.3	90.7	92.0	89.3	91.7	90.3	89.7	91.7	90.7	93.0	92.0	90.0	89.7	91.65
25	1583543	F	S	78.7	81.3	80.7	79.3	79.0	78.7	79.0	79.7	76.3	80.3	79.0	80.0	78.7	80.0	81.3	81.7	82.0	76.3	80.0	79.76
26	1581582	F	S	97.3	94.0	94.3	90.7	92.0	91.0	95.0	91.0	89.7	89.3	87.3	88.7	89.0	84.3	88.7	87.3	87.3	89.0	87.7	90.73
27	1571944	F	D	76.3	77.0	78.0	77.7	78.3	74.3	77.3	76.3	77.3	80.0	74.3	74.3	78.7	78.3	75.0	76.0	80.0	79.0	75.7	77.84
28	1583136	F	D	77.7	77.0	79.3	78.3	78.7	78.3	78.7	76.3	74.7	83.3	83.7	84.3	83.3	85.7	85.3	82.7	84.0	85.0	87.0	81.71
29	1586282	F	D	81.7	79.0	82.0	82.3	82.7	81.7	78.7	79.7	80.0	77.3	76.0	79.7	82.7	86.0	86.3	83.3	81.0	84.0	81.7	81.79
30	1587268	M	D	70.7	70.7	69.7	70.7	69.7	68.7	67.7	70.0	69.0	69.3	68.7	70.0	70.3	70.7	70.7	71.3	69.7	70.0	69.0	70.32
31	1587954	F	S	93.0	92.3	90.7	89.7	86.7	87.7	85.3	86.0	85.7	86.7	88.3	90.3	87.3	86.0	85.3	88.3	86.0	82.7	84.3	88.60
32	236636	M	S	95.3	94.0	92.7	92.3	91.3	89.3	90.7	92.3	91.0	89.7	91.0	90.0	86.3	86.3	83.3	85.0	87.3	90.3	89.7	90.51
33	797257	F	D	83.0	84.3	78.3	78.7	77.7	83.7	84.0	83.7	82.3	78.3	74.7	75.7	72.7	74.3	75.0	80.0	83.0	79.7	80.7	80.51
34	7727	F	D	71.3	72.3	71.0	70.7	72.7	72.7	75.3	74.3	76.7	74.3	76.7	77.7	80.0	79.7	73.0	72.0	71.7	71.7	72.7	74.43
35	1582991	F	D	80.3	77.3	78.7	77.0	75.3	77.3	77.7	74.0	75.0	76.3	76.0	77.0	79.3	78.3	70.3	70.7	70.7	70.3	69.7	76.00
36	1587603	F	D	69.7	70.3	72.7	70.0	71.0	70.3	70.7	68.3	68.0	69.0	70.7	70.0	69.0	71.3	72.3	72.7	68.7	67.0	69.7	70.73
37	1588934	F	S	79.3	80.7	82.3	81.0	84.7	83.3	85.0	87.7	89.7	83.7	86.3	92.7	88.0	92.0	85.0	86.7	91.7	90.0	85.3	85.68
38	1588817	F	S	92.7	91.7	94.0	87.3	91.0	94.7	86.3	93.7	91.3	92.0	92.3	94.0	87.3	92.0	94.7	88.0	88.7	83.3	88.3	91.17
39	1589332	F	D	73.7	75.3	71.3	75.7	70.3	67.7	67.3	70.0	69.7	71.3	73.7	76.3	73.0	69.3	69.3	74.0	73.0	72.0	75.3	73.02
40	1585586	F	D	75.3	75.0	76.0	78.3	78.0	78.0	77.0	75.3	74.0	74.7	74.7	78.0	72.3	73.7	74.7	80.0	78.7	77.0	78.7	77.17
41	1586846	M	D	72.7	74.3	69.3	71.7	70.0	71.0	69.0	68.7	70.3	70.7	71.3	69.3	68.3	67.0	73.3	69.7	69.0	70.0	72.7	71.19
42	1589267	F	S	101.0	99.0	96.3	96.0	95.7	98.0	95.3	96.0	92.7	90.7	93.3	92.7	94.7	97.0	96.0	95.0	94.7	95.3	95.7	96.06
43	1588558	F	D	70.0	71.7	67.7	69.7	70.7	73.3	68.7	69.3	70.0	74.7	70.0	69.3	69.7	70.0	71.7	68.0	69.0	69.3	67.7	70.60
44	1600216	F	D	67.7	70.7	74.3	70.7	70.3	68.0	69.3	68.0	68.0	71.3	69.3	69.3	70.3	67.3	71.7	71.0	73.7	76.7	75.3	71.19
45	1599292	F	D	69.3	72.0	71.7	69.3	68.7	72.0	76.3	75.3	78.3	76.7	73.3	76.3	70.7	70.7	73.3	72.3	72.7	73.7	73.3	73.33
46	1602534	M	D	70.0	69.3	65.7	68.7	68.3	71.3	68.3	68.3	69.7	69.7	72.0	70.7	70.3	75.3	71.7	70.7	71.7	72.7	73.3	70.44
47	430731	F	S	91.3	90.3	92.0	95.0	93.0	92.0	94.0	94.7	94.0	95.0	95.7	95.3	96.3	94.3	93.3	92.3	91.3	92.3	95.3	93.75
48	1602972	F	D	85.3	84.0	87.7	82.7	84.0	85.3	86.3	85.7	88.0	85.7	84.3	83.3	83.0	85.0	84.3	83.7	85.3	87.3	88.3	86.43
49	1514721	M	S	78.3	77.0	75.7	74.3	75.0	76.0	76.3	72.7	73.7	71.0	70.7	69.7	71.3	74.0	75.3	76.3	78.0	80.0	81.0	75.56
50	1605081	M	S	76.7	79.3	80.0	79.7	80.0	79.7	79.0	76.3	77.3	78.3	83.7	83.3	82.0	81.0	81.0	78.0	80.3	78.3	79.0	79.17
51	1607040	M	S	79.7	80.7	78.0	84.0	77.3	79.3	79.7	77.0	77.3	76.7	79.3	84.0	85.0	83.3	80.3	80.0	81.0	79.0	83.3	80.10
52	1606137	M	D	70.3	74.0	72.7	71.3	69.3	68.3	71.3	68.3	68.7	72.3	68.7	68.7	70.0	70.3	66.7	66.7	66.7	67.3	69.7	70.40

Sr No	MRD No.	Sex	GROUP(D/S)	BSPI	PI 1 MIN	PI 2 MIN`	PI 3 MIN	PI 4 MIN	PI 5 MIN	PI 6 MIN	PI 7 MIN	PI 8 MIN	PI 9 MIN	PI 10 MIN	PI 11 MIN	PI 12 MIN	PI 13 MIN	PI 14 MIN	PI 15 MIN	PI 16 MIN	PI 17 MIN	PI 18 MIN	PI 19 MIN	PI 20 MIN	AV PI
1	950443	M	S	3.3	11.1	12.2	13	13	12.9	8.5	8.7	12.9	12.8	12.4	10.2	12.4	10.4	12	12.8	12.9	13	12.5	10.1	12.7	11.42
2	1447365	F	S	1.5	12.4	14	15	12.6	12.8	13	12.9	12.9	12.9	13	13.8	13.4	13.6	13.5	12.8	12.4	12.9	12.3	12.8	12.8	12.54
3	1435648	F	S	9.5	9.9	9.9	10.1	10.2	10.1	9.9	10.1	10.7	10.5	10.2	10.7	10.1	10.2	10.6	10.7	10.4	10.4	9.6	9	10	10.13
4	1462715	M	S	2.1	4.3	5.4	5.9	5	5.1	5.3	5.1	4.9	4.8	4.5	4.7	4.8	4.5	3.6	3.5	3.2	3.2	3.6	3.6	3.5	4.31
5	1442067	M	S	1.56	0.85	0.92	0.91	0.87	1	0.95	0.92	0.91	1.1	0.95	1.09	1.12	1.08	0.92	1.09	1.1	0.97	0.96	0.97	1.01	1.01
6	1465195	M	D	3.5	10.8	12	10.6	13	14	15	16	15.9	15.8	15.6	15.9	15.8	15.4	15.7	15.7	15.8	15.6	15.6	15.4	15.8	14.23
7	1240195	F	D	1.3	5.3	6.7	4.4	3.9	4	4.7	4.6	5	4.9	5	5.1	4	4.1	3.9	3.9	3.8	3.6	4.1	3.9	3.6	4.28
8	1468676	M	D	2.1	1.9	4.7	5.1	6	6.2	6	5.9	5.2	5.3	5	6	5.9	6.1	2.8	3.9	2.9	2.9	2.7	3	5	4.50
9	1465477	F	D	2.5	9.8	10	9.9	10	10	10	7.5	8.8	6.6	8.9	9	4.5	7.9	4.1	3.4	4.2	4.6	5	4.4	4.1	6.91
10	1464857	M	D	2.6	7.4	7.8	8.1	8.4	8.5	8.4	8.4	8.7	8.4	8.1	8.2	7.8	7.9	7.8	7.9	8	8.2	8.1	7.8	5.8	7.73
11	1473414	M	D	1.5	9.3	9.3	9.2	10.6	9.1	10.8	10.1	10.9	10.3	11	8.5	8.2	9.1	8.6	9.9	8.8	7.6	8.1	9.2	9.1	9.01
12	1349887	F	S	2.8	2.7	3	2.9	3.1	3.2	3.2	2.9	2.9	3.2	3	3.5	2	3.4	2.4	2.2	2.3	2.2	3	2.9	2.5	2.82
13	1528415	F	S	7.2	8.4	9	8.9	8.3	8.4	8.5	9.8	10.1	12.2	9.9	10.1	8.1	7.8	7.9	8.2	8.4	8.6	7.9	7.5	7.4	8.70
14	802484	F	S	5.9	5.8	6.9	6.8	8.1	7.4	6.9	6.8	7.5	6.8	5.9	5.9	6.7	5.5	4.9	6.2	6.3	6.7	7.1	7.1	7.2	6.59
15	1398466	M	S	2.5	3.9	3.9	3.8	3.9	3.9	3.7	3.8	4.9	3.8	3.7	3.9	3.7	3.5	4	3.3	3.5	4.6	3.9	3.8	4.5	3.83
16	1548660	M	D	4.1	5	5	5	5.8	5.9	5.6	5.8	6.4	6.4	5.6	5.7	4.9	5.9	5.7	5.7	5.9	6	6.1	6	6.3	5.66
17	1555465	M	S	9.6	11.2	10.8	10.2	9.9	9.8	9.3	9.4	9.5	10.1	9.2	11.1	11.2	10	10.6	11.7	12.1	9.2	9.8	9.9	10.2	10.23
18	1550989	M	S	1.3	0.9	0.8	0.8	0.7	1.2	1.3	1.4	1.6	2.1	2.2	1.8	1.9	2	2.4	2.6	2.3	0.8	0.9	0.8	0.7	1.45
19	1540001	M	S	5.4	3.2	3.3	3.1	3	2.9	2.8	2.5	2	1.9	1.8	1.6	1.7	1.8	1.2	3.6	4.2	4.6	4.4	4.3	4.2	3.02
20	1417076	F	S	10.2	11.2	11.4	11	10.9	10.8	10.7	10.2	9.8	9.9	10.1	11	10.9	10.6	11.1	12	12.1	10.8	10.4	10.2	10.4	10.75
21	1489867	M	S	5	5.9	5.8	6	6.1	6	5.9	6.1	6.1	6.2	6.2	6.4	6.6	6.6	6.8	6.9	6.2	6	6.1	6.2	6.3	6.16
22	1568237	F	S	3.1	5.9	5.5	5.1	5.1	4.8	4.5	4.6	4.8	5	5	4.9	4.9	3.4	4.1	3.4	3.4	4.1	4.2	4.3	4.3	4.50
23	1568533	F	D	3.4	6.2	7.1	6.3	7.2	6.9	6.3	7.9	6.3	6.2	7.2	7.1	6.4	6.4	7.3	7.3	7.2	7.4	7.4	7.4	7.6	6.79
24	1579474	F	S	1	1.8	1.8	1.8	1.9	1.9	1.8	2.1	1.9	1.8	1.8	2.4	1.8	2.1	2	1.7	1.8	1.7	1.8	2.1	2.2	1.87
25	1583543	F	S	6.4	6.9	7.1	6.8	6.9	7	7.2	7.2	7.1	7	7.4	7	7.2	7.2	7.3	7	6.9	6.4	6.5	7.7	7	7.01
26	1581582	F	S	2.4	1.5	1.6	1.6	1.7	1.8	2	1.9	1.5	1.9	2.4	2.5	3	2.8	2.9	3.9	2.7	3	3.1	2.9	3	2.39
27	1571944	F	D	4.7	8.3	9.1	8.4	8.2	8.1	7.9	9.3	8.3	8.3	8.2	7.2	9.4	9.5	7.7	8.1	9	9	7	7.5	9.1	8.20
28	1583136	F	D	2.1	3.9	4	4.2	4	4	3.8	4.2	3.8	4.1	4.8	3.9	3.5	3.6	3.7	3	2.9	3.6	3.5	3.1	2.9	3.65
29	1586282	F	D	3.4	7.9	7.2	7.4	7.1	7.1	7.2	7.2	7.9	7.5	7.4	7.8	8.1	7.4	7.1	5.8	5.8	6.9	7.4	5.8	7.4	6.99
30	1587268	M	D	5.4	10.9	11	11.4	11.5	11.4	11.6	11.8	11.9	11.4	11.4	11.6	11.8	11.4	11.4	11.3	11.3	11.2	11.6	11.3	11.4	11.14
31	1587954	F	S	2.5	3.9	3.9	3.9	4	4.1	4.2	4.1	4.3	4.1	4.3	4.2	4.1	4.1	4.2	4.3	4.4	4	4.2	4.6	4.4	4.09
32	236636	M	S	2.6	4.3	4	4	4.7	5	4.9	5.1	4.8	4.9	4.9	5.2	4.8	5	5.7	6	6.4	6.1	6	5.1	5.1	4.98
33	797257	F	D	1	3.9	3.5	3.8	4.3	4.1	4.2	4	3.9	3.8	3.5	4.3	4.9	4.9	5.5	5	4.9	4	3.5	4.1	3.9	4.05
34	7727	F	D	2.9	6	6.5	6.2	6.4	6.4	6.1	6	5.8	5.7	5.2	5.7	5.1	5	4	4.1	6	6.2	6.1	6.3	6	5.60
35	1582991	F	D	4.5	5.6	5.7	7.8	6.1	7.9	8.4	8	7.5	8.7	8.6	8.5	8.5	8	6.1	6.1	9.1	9.1	8.9	9	9	7.67
36	1587603	F	D	3.9	7.1	7.5	7.3	6.4	7.4	7.1	7.4	7	7.9	8	8.1	7	7.4	8	7	6.9	6.4	8.1	8	7.5	7.21
37	1588934	F	S	3.5	5	5	4.5	4	4.3	3.5	3.6	3.4	3	2.8	3.6	3.3	2.3	2.9	2.3	3.4	3.3	2.4	2.2	3.4	3.41
38	1588817	F	S	2.5	3.1	3.9	4.1	3.1	5.1	4.1	3	5.2	3.2	4.1	3.9	3.9	3.2	5	3.9	3.2	4.9	4.5	4.9	4.5	3.97
39	1589332	F	D	5.1	7.9	8.6	8.3	8.8	8.3	8.8	9.1	9	8.7	8.8	8.8	8.4	8.2	8.3	8.5	8.5	8.1	8.4	8.5	8.3	8.35
40	1585586	F	D	2.4	6.2	6.1	6	5.9	5.8	5.7	5.7	5.6	6	6.1	6.1	6.2	5.7	6.4	6.3	6.2	4.1	4.9	4.8	4.7	5.57
41	1586846	M	D	4	6.4	6.6	6.2	7.8	7.1	7.3	7.1	7.8	8	7.4	7.5	7	7.9	7.9	8.1	6.6	7.7	7.8	7.5	6.7	7.16
42	1589267	F	S	2.4	4.2	3.9	3.9	4.6	4.7	4.9	4.1	4.9	4.6	5.6	6	5.2	5.7	5.1	4.3	4.5	4.9	5.1	4.9	4.9	4.69
43	1588558	F	D	6.4	10.3	10	9.6	10.5	10.2	10.1	9.4	10.3	10.3	10.1	9.4	10.1	10.2	10.3	10	10.5	10.5	10.3	10.3	10.5	9.97
44	1600216	F	D	2.5	6	6.4	5.6	6	5.7	5.7	6.1	5.9	5.9	5.9	5.6	5.9	5.8	5.7	6.3	5.6	5.5	4.9	5.7	4.1	5.56
45	1599292	F	D	2.4	7.5	7.2	6.5	6.4	7.1	7.4	6.1	5.4	5.7	5	5.4	5.9	5.5	6.9	6.9	6	6.2	6.1	6	5.6	6.06
46	1602534	M	D	4.1	6.9	6.1	6.2	6.8	6.5	6.5	5.9	6.4	6.4	6.2	6.2	5.6	6.1	6.1	6.4	5.9	6.1	5.9	5.5	5.4	6.06
47	430731	F	S	7	7.6	8.4	8.6	8.2	7.3	7.8	8.2	7.6	7.6	7.5	7.4	7.3	7.4	7.1	7.9	7.8	8.2	8.4	8.2	7.4	7.76
48	1602972	F	D	1.15	4.9	6.1	6.5	5.6	6.9	6.5	6	5.8	6.1	5.1	6	6.5	6.7	6.9	6.1	6.5	6.9	6.1	5.5	5.2	5.86
49	1514721	M	S	3.1	3.1	3.6	3.7	4	4	4	4.2	4.1	4.9	5	4.8	5.5	5.5	5	4.1	4	4.2	3.6	3.2	3.2	4.13
50	1605081	M	S	5.4	4.5	4.6	4.2	4	3.9	3.9	4	3.9	4.5	4.4	3.8	2.1	2.1	3.7	3.7	3.6	3.9	3.8	3.7	3.8	3.88
51	1607040	M	S	1.4	1.9	1.6	1.3	1.4	0.9	1.8	1.5	1.6	1.8	1.8	2	1.5	1	1	0.9	1.3	1.3	1.1	1.5	1.1	1.41
52	1606137	M	D	1.4	4.9	4.8	4	4.5	4.6	4.7	5	4.9	5	5	4.9	5.1	4.9	4.8	4.9	4.3	4.3	4.3	4.2	5	4.55

Sr No	MRD No.	Sex	GROUP(D/S)	Pt Initials	AGE(YEARS)	ASA	BS PR	HR 1 MIN	HR 2 MIN	HR 3 MIN	HR 4 MIN	HR 5 MIN	HR 6 MIN	HR 7 MIN	HR 8 MIN	HR 9 MIN	HR 10 MIN	HR 11 MIN	HR 12 MIN	HR 13 MIN	HR 14 MIN	HR 15 MIN	HR 16 MIN
53	1580119	M	D	RP	40	2	95	104	102	105	110	104	100	98	99	95	97	95	94	92	90	92	93
54	76138	M	D	ST	36	2	68	74	71	78	70	78	80	81	84	79	78	77	80	80	81	84	82
55	1609653	F	S	SK	24	1	92	88	84	80	88	89	91	92	90	84	87	88	89	90	94	93	92
56	1611174	M	D	R	24	1	65	80	84	86	89	89	88	89	90	92	92	90	90	89	88	92	91
57	1593108	M	D	M	21	1	72	90	91	92	88	89	90	92	93	90	91	92	94	94	95	95	96
58	1617817	M	D	VS	37	2	84	98	98	99	99	97	97	96	96	95	95	95	94	93	96	94	93
59	1609366	F	S	N	22	1	72	77	78	84	80	82	81	79	80	82	84	85	82	79	79	78	78
60	1649103	M	S	BS	38	1	96	110	109	108	102	99	98	97	96	95	95	95	94	94	96	95	95

Sr No	MRD No.	Sex	GROUP(D/S)	HR 17 MIN	HR 18 MIN	HR 19 MIN	HR 20 MIN	AV HR	BS SBP	SBP 1 MIN	SBP 2 MIN	SBP 3 MIN	SBP 4 MIN	SBP 5 MIN	SBP 6 MIN	SBP 7 MIN	SBP 8 MIN	SBP 9 MIN	SBP 10 MIN	SBP 11 MIN	SBP 12 MIN
53	1580119	M	D	94	95	96	90	97.14	129	92	93	94	89	88	86	90	91	94	98	99	101
54	76138	M	D	82	80	81	81	78.52	109	99	95	92	96	97	92	94	100	96	94	93	97
55	1609653	F	S	90	88	86	87	88.67	141	120	125	122	125	130	120	121	122	125	129	128	120
56	1611174	M	D	91	90	89	88	87.71	125	110	111	109	108	102	101	100	105	104	103	102	102
57	1593108	M	D	97	98	99	99	92.24	110	99	98	97	100	96	97	97	92	94	94	94	90
58	1617817	M	D	92	91	90	91	94.43	110	91	92	94	92	94	92	92	90	91	90	94	93
59	1609366	F	S	78	77	77	78	79.52	110	108	107	106	107	105	105	104	104	107	108	109	100
60	1649103	M	S	92	90	90	89	96.90	130	122	120	119	119	122	124	118	117	115	119	120	124

Sr No	MRD No.	Sex	GROUP(D/S)	SBP 13 MIN	SBP 14 MIN	SBP 15 MIN	SBP 16 MIN	SBP 17 MIN	SBP 18 MIN	SBP 19 MIN	SBP 20 MIN	AV SBP	BS DBP	DBP1 MIN	DBP 2 MIN	DBP 3 MIN	DBP 4 MIN	DBP 5 MIN	DBP 6 MIN	DBP 7 MIN
53	1580119	M	D	104	105	103	109	110	111	108	107	100.05	82	68	66	60	62	65	69	62
54	76138	M	D	90	89	88	85	92	93	93	95	94.24	65	62	60	59	58	55	56	57
55	1609653	F	S	118	115	117	121	124	122	127	125	123.67	92	89	84	82	86	81	75	79
56	1611174	M	D	107	106	105	105	104	104	108	107	106.10	81	70	69	72	74	72	72	74
57	1593108	M	D	90	91	91	90	89	90	88	89	94.10	70	68	68	65	65	63	62	62
58	1617817	M	D	92	94	94	93	93	93	95	96	93.57	70	62	63	65	66	69	65	66
59	1609366	F	S	104	107	102	102	105	104	106	107	105.57	70	62	62	62	61	61	61	60
60	1649103	M	S	126	120	118	119	120	121	122	119	120.67	85	81	80	79	78	70	75	76

Sr No	MRD No.	Sex	GROUP(D/S)	DBP 8 MIN	DBP 9 MIN	DBP 10 MIN	DBP 11 MIN	DBP 12 MIN	DBP 13 MIN	DBP 14 MIN	DBP 15 MIN	DBP 16 MIN	DBP 17 MIN	DBP 18 MIN	DBP 19 MIN	DBP 20 MIN	AV DBP	BS MAP	MAP 1 MIN
53	1580119	M	D	60	63	60	59	70	71	72	70	74	72	70	68	73	67.43	97.7	76.0
54	76138	M	D	59	57	58	61	60	61	67	62	70	68	64	66	65	61.43	79.7	74.3
55	1609653	F	S	81	86	80	79	83	83	80	84	74	79	81	80	76	81.62	108.3	99.3
56	1611174	M	D	69	72	73	73	72	71	72	73	73	72	72	70	70	72.19	95.7	83.3
57	1593108	M	D	64	60	61	61	64	63	64	64	60	60	61	64	63	63.43	83.3	78.3
58	1617817	M	D	62	61	62	63	64	66	62	66	62	62	65	66	67	64.48	83.3	71.7
59	1609366	F	S	60	63	62	62	64	65	60	63	63	64	66	63	64	62.76	83.3	77.3
60	1649103	M	S	78	78	79	75	80	81	79	79	79	80	79	78	75	78.29	100.0	94.7

Sr No	MRD No.	Sex	GROUP(D/S)	MAP 2 MIN	MAP 3 MIN	MAP 4 MIN	MAP 5 MIN	MAP 6 MIN	MAP 7 MIN	MAP 8 MIN	MAP 9 MIN	MAP 10 MIN	MAP 11 MIN	MAP 12 MIN	MAP 13	MAP 14	MAP 15	MAP 16	MAP 17	MAP 18	MAP 19	MAP 20	AV MAP
53	1580119	M	D	75.0	71.3	71.0	72.7	74.7	71.3	70.3	73.3	72.7	72.3	80.3	82.0	83.0	81.0	85.7	84.7	83.7	81.3	84.3	78.30
54	76138	M	D	71.7	70.0	70.7	69.0	68.0	69.3	72.7	70.0	70.0	71.7	72.3	70.7	74.3	70.7	75.0	76.0	73.7	75.0	75.0	72.37
55	1609653	F	S	97.7	95.3	99.0	97.3	90.0	93.0	94.7	99.0	96.3	95.3	95.3	94.7	91.7	95.0	89.7	94.0	94.7	95.7	92.3	95.63
56	1611174	M	D	83.0	84.3	85.3	82.0	81.7	82.7	81.0	82.7	83.0	82.7	82.0	83.0	83.3	83.7	83.7	82.7	82.7	82.7	82.3	83.49
57	1593108	M	D	78.0	75.7	76.7	74.0	73.7	73.7	73.3	71.3	72.0	72.0	72.7	72.0	73.0	73.0	70.0	69.7	70.7	72.0	71.7	73.65
58	1617817	M	D	72.7	74.7	74.7	77.3	74.0	74.7	71.3	71.0	71.3	73.3	73.7	74.7	72.7	75.3	72.3	72.3	74.3	75.7	76.7	74.17
59	1609366	F	S	77.0	76.7	76.3	75.7	75.7	74.7	74.7	77.7	77.3	77.7	76.0	78.0	75.7	76.0	76.0	77.7	78.7	77.3	78.3	77.03
60	1649103	M	S	93.3	92.3	91.7	87.3	91.3	90.0	91.0	90.3	92.3	90.0	94.7	96.0	92.7	92.0	92.3	93.3	93.0	92.7	89.7	92.41

Sr No	MRD No.	Sex	GROUP(D/S)	BSPI	PI 1 MIN	PI 2 MIN`	PI 3 MIN	PI 4 MIN	PI 5 MIN	PI 6 MIN	PI 7 MIN	PI 8 MIN	PI 9 MIN	PI 10 MIN	PI 11 MIN	PI 12 MIN	PI 13 MIN	PI 14 MIN	PI 15 MIN	PI 16 MIN	PI 17 MIN	PI 18 MIN	PI 19 MIN	PI 20 MIN	AV PI
53	1580119	M	D	1.9	5.9	6	6.8	6.9	6.8	6.1	7.4	7	6.6	6.8	6.5	5.6	5.2	4.9	5.2	4.1	4.5	4.9	5.2	4.5	5.66
54	76138	M	D	3.4	6.1	6.9	7.2	7.2	7.4	7.5	7.3	6.9	7.2	7.1	6.9	6.9	7.1	6.1	7.1	6	5.7	6.4	5.9	5.9	6.58
55	1609653	F	S	4.7	6.6	7	7.4	6.6	7	8.2	7.9	7.5	6.6	7.1	7.4	7.4	7.6	8.1	7.4	8.2	7.6	7.6	7.4	8	7.30
56	1611174	M	D	4.1	9.8	10	9.2	9.1	10.3	10.5	10.2	10.4	10.2	9.8	10.2	10.2	9.8	9.7	9.8	9.9	10.1	10.2	10.2	10.1	9.70
57	1593108	M	D	1.4	5.5	5.4	5.8	5.7	6.1	6.6	6.7	6.7	7.4	7.2	7.1	7.1	7	6.8	6.7	7.8	8	7.8	7.2	7.4	6.54
58	1617817	M	D	2.4	6.8	6.7	6	6	5.2	6.1	6.1	6.8	6.8	6.9	6.3	6.3	6	6.5	5.9	6.6	6.6	6	5.8	5.4	6.06
59	1609366	F	S	2.1	4.2	4.1	4.6	4.7	5.1	5.1	5.9	5.8	4.3	4.3	4.2	4.7	3.8	5	4.5	4.6	4.2	3.7	4.2	3.7	4.42
60	1649103	M	S	1.1	2.5	2.9	2.9	3.2	4	3.3	3.5	3.3	3.6	3.1	3.6	2.5	2.3	3.1	3.1	3	2.8	2.8	3	3.8	3.02

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The Principal
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Subject:: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 25.09.2023 has approved the plan of thesis of **Gunjan**, a student of your college for **MD Anaesthesiology** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
A comparative study to evaluate vasodilatory effect of desflurane vs sevoflurane using perfusion index .

Supervisor
Dr. Neeru Luthra
Professor
Dept. of Anaesthesiology,

Co-Supervisor:-
Dr. Tanveer Signh
Assoc. Professor
Dept. of Anaesthesiology

The student may submit the thesis in triplicate alongwith the plan in triplicate also, to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She may be directed to attach a photocopy of this letter with the forwarding letter while submitting thesis in the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic, if any.

Controller of Examinations

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*

A COMPARATIVE STUDY TO EVALUATE VASODILATORY EFFECT OF DESFLURANE VS SEVOFLURANE USING PERFUSION INDEX

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF MEDICINE

IN

ANAESTHESIOLOGY

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

DR. GUNJAN

AUGUST, 2022

DEPARTMENT OF ANAESTHESIOLOGY
DAYANAND MEDICAL COLLEGE & HOSPITAL,
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	A comparative study to evaluate Vasodilatory effect of Desflurane vs Sevoflurane using Perfusion Index
For the degree of	M.D. Anaesthesiology
Name of the candidate	Dr. Gunjan
Supervisor	Dr. Neeru Luthra, Professor, Department of Anaesthesiology, DMCH, Ludhiana
Co-supervisor	Dr. Tanveer Singh, Associate Professor, Department of Anaesthesiology, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Sevoflurane and Desflurane are the most commonly used inhalational anaesthetics. These anaesthetics volatile cause dose-dependent effect on cardiovascular function, either through effects on the myocardium itself or by decreasing systemic vascular resistance (SVR) and sympathetic outflow. Perfusion index (PI) can effectively assess peripheral perfusion dynamics and vascular tone. It can be non-invasively and continuously obtained using pulse oximeter. With this background this study has been designed to compare the vasodilatory properties of Desflurane and Sevoflurane.

Aim of Study: To compare vasodilatory properties of Sevoflurane vs Desflurane using perfusion index

Materials & methods: A prospective randomized study will be conducted on 60 patients posted for surgery under general anaesthesia divided into two equal groups. Sevoflurane or Desflurane at 1.0 MAC will be used to maintain anaesthesia as per group allocation. PI will be recorded and compared in both the groups.

Clinical Significance: Clinically, changes in heart rate and blood pressure are most important because, in patients at an increased risk of cardiovascular complications, both hypotension and tachycardia may cause a dramatic increase in the incidence of perioperative adverse events. PI is a novel predictor of changes in peripheral vasomotor tone. Hence, this study will help compare the two inhalational agents and find better agent with minimal perioperative adverse events due to tachycardia and hypotension

Keyword: Prospective Study, Perfusion Index, Inhalational Anaesthetics, Vasodilation.

(Signature) Candidate	(Signature) Co-supervisor	(Signature) Supervisor	(Signature) Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"A COMPARATIVE STUDY TO EVALUATE VASODILATORY EFFECT OF DESFLURANE VS SEVOFLURANE USING PERFUSION INDEX"** exist in the Department of Anaesthesiology at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

Dr. Neeru Luthra
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Co-Supervisor

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Head of the Department

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Place:_____

Date:_____

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr Gunjan
Department	Anaesthesiology
Topic of Thesis	A comparative study to evaluate Vasodilatory effect of Desflurane vs Sevoflurane using Perfusion Index
Likely date of appearing in PG examination	MAY-JUNE 2024
Date of enrollment	5th March 2022
Name of Head of Department	Dr. Anju Grewal
1) Supervisor **2) Co-Supervisor**	Dr. Neeru Luthra Dr. Tanveer Singh
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Jaspal Singh (Professor & Head, Surgery	Mr. R K Sharma (Legal Expert)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Assistant Dean Academics)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
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	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / ~~No~~

Dr. Sandeep Puri
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Research Committee
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Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee
Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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2	NAME OF THE INSTITUTE	DAYANAND MEDICAL COLLEGE AND HOSPITAL, LUDHIANA
3	COURSE OF STUDY AND SUBJECT	M.D. ANAESTHESIOLOGY
4	DATE OF ADMISSION OF COURSE	5th MARCH 2022
5	TITLE OF THE TOPIC	A comparative study to evaluate Vasodilatory effect of Desflurane vs Sevoflurane using Perfusion Index

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Inhaled anaesthetics are vital components for induction and maintenance of general anaesthesia. Sevoflurane and Desflurane are the most commonly used general anaesthetics in adult surgical procedure due to their potency and rapid pharmacokinetic profiles.[1,2]

Desflurane is the volatile agent with low blood: gas partition coefficient (0.42). Its elimination from the body is rapid, which results in fast onset and recovery from anaesthesia. Sevoflurane has a blood: gas partition coefficient of 0.65, which is slightly greater than Desflurane.[3]

All volatile agents cause dose-dependent effect on cardiovascular function, either through effects on the myocardium itself or by decreasing systemic vascular resistance (SVR), sympathetic outflow or a combination of these.[4–6] Hemodynamic compensatory responses are attenuated by volatile anaesthetics[5] Lower SVR produced by Desflurane is predominantly assigned to dilatation of arteriolar resistance vessels, whereas Sevoflurane-induced decrease in left ventricular afterload may occur primarily via altering mechanical properties of the aorta[6,7]

Intraoperative hypotension is a common side-effect of general anaesthesia that has received much attention in recent years because of its frequent occurrence and presumed adverse consequences. Clinically, changes in heart rate and blood pressure are important because, in patients at an increased risk of cardiovascular complications, both hypotension and tachycardia may cause a dramatic increase in the incidence of perioperative adverse events.[8] More recent landmark studies have shown associations between hypotension and other adverse outcomes such as acute kidney injury (AKI) and myocardial injury (MI). Many patients are vulnerable to perioperative complications due to combination of physiological frailty and comorbid diseases.

Obtaining quantitative measurements of vasodilation caused by anaesthetics is challenging because of the need for invasive procedures. Moreover, the calculated SVR is not solely attributed to peripheral vasomotor tone.[7,9] Vasodilatory responses induced by volatile anaesthetics can increase microvascular perfusion. Improved peripheral perfusion is associated with an increase in tissue oxygen tension, which may reduce tissue infection and improve wound repair.[6,10] Conversely, volatile anaesthetics with more potent vasodilatory properties may promote hypotension, which is associated with adverse perioperative outcomes.

The ability to predict and categorize the patients who are at particular risk of developing severe hypotension would enable anaesthesiologist to prepare appropriately, and also to potentially individualise treatment modalities. Many attempts have been made to look for predictors of hypotension some of them being baseline heart rate variability (HRV), IVC collapsibility, and pleth variability index (PVI).

One novel predictor which has shown promise is the use of perfusion index (PI) which effectively assesses peripheral perfusion dynamics and vascular tone.[11,12] It can be non-invasively and continuously measured using pulse oximeter. PI can be used as a surrogate for quantitative measurement of vasoconstriction and vasodilation produced by vasoactive drugs, including volatile anaesthetics.

PI is defined as the ratio of pulsatile blood flow to non-pulsatile blood flow in the peripheral vascular tissue, measured using a pulse oximeter based on the amount of infrared light absorbed. The principle is similar to that of peripheral oxygen saturation (SpO_2) which is based on two light sources of different wavelength (660nm and 940 nm) emitted through cutaneous vascular bed.[12,13] Both wavelengths have a pulsatile component representing the fluctuations of arterial blood and non-pulsatile component from connective tissue, bone and venous components.[11-14] Various studies carried out previously for both

general anaesthesia as well as spinal, have employed PI to assess haemodynamic parameters (i.e Systolic and Mean BP).

In a study conducted by Ryu et al perfusion index was used to compare the vasodilatory properties of Desflurane and Sevoflurane and found a positive correlation was found between PI and vasodilation. They observed that at equi-anaesthetic concentration of 1.0 MAC, Desflurane produced higher PI values than did Sevoflurane, but substantially lower MAP. The authors suggested that Desflurane has greater vasodilating effects than Sevoflurane at equi-anaesthetic concentrations.[6]

These findings suggest that the PI has the potential to be used as an alternative non invasive approach for estimating vasoconstriction or vasodilation. However, there is limited data to assess vasodilation caused by inhalational agents using PI as a marker. This study is designed to use PI to compare the vasodilatory properties of Sevoflurane vs Desflurane in patients undergoing elective surgery under general anaesthesia.

6.2 REVIEW OF LITERATURE

Inhaled anaesthetics are vital components for induction and maintenance of general anaesthesia. Sevoflurane and Desflurane are commonly used as general anaesthetics, owing to their rapid pharmacokinetic profiles.[6,15] Their lower solubility provides a more precise control over delivery and a more rapid recovery from anaesthesia. All volatile anaesthetics cause agent and dose-dependent decreases in SVR and myocardial contractility to varying degrees, ultimately leading to decreases in arterial pressure.[6,7,16] Previous studies in chronically instrumented animals have shown that Desflurane and Sevoflurane produce similar dose dependent decreases in myocardial contractility. Vasodilatory responses induced by volatile anaesthetics can increase microvascular perfusion. Improved peripheral perfusion is associated with an increase of tissue oxygen tension, which may reduce tissue infection and improve wound repair. Conversely, volatile anaesthetics with more potent vasodilatory properties may promote hypotension, which is associated with adverse perioperative outcome.[8]

In a study by **Lowe d et al** demonstrated that low SVR produced by Desflurane was predominantly assigned to be caused by dilatation of arteriolar resistance vessels, whereas Sevoflurane-induced decreases in left ventricular afterload may occur primarily via altering mechanical properties of the aorta.[7]

In a study done by **Rodig G et al**, conducted on 52 patients used cardiopulmonary bypass to exclude the cardiac effects of inhalational agents and solely study the effect on systemic vasculature concluded that vasodilatation may be attributed to the direct relaxant actions on vascular smooth muscle, reduction in sympathetic output or reduction in the effectiveness of other stimuli on the vascular smooth muscle.[17].

The pulse oximeter is a basic monitor in medical practice with an essential role to evaluate the peripheral oxygen saturation and heart

rate using plethysmography technology. Pulse oximetry derived peripheral perfusion index (PPI) is another variable that is measured by pulse oximeters. The PPI represents the ratio between the portions of the blood in the peripheral tissue, namely, the pulsatile and the non-pulsatile blood flow. The non-pulsatile component is from connective tissue, bone and venous compartment. The perfusion index (PI) is the ratio of the pulsatile component (arterial) and non-pulsatile component of light reaching the detector. PPI values depend on the blood flow in the peripheral circulation and the vascular tone; thus, it reflects two main determinants, which are the cardiac output and the balance between the sympathetic and the parasympathetic nervous systems. PI indicates the status of the microcirculation which is densely innervated by sympathetic nerves, and therefore, is affected by multiple factors responsible for vasoconstriction or vasodilatation of the microvasculature.[1] It is also purported to be an indicator of systemic vascular resistance (SVR).In a study published by **Elshal et al** it was concluded that PI is an irreplaceable vital sign with many important uses, such as a prognostic marker in critically ill and surgical patients, guiding fluid and vasopressor management, assessing the success of weaning from mechanical ventilation, and can be used as an objective measure for the assessment of regional anaesthesia and pain.[18].

Duggappa DR et al, in their study on healthy parturient undergoing elective caesarean section under SAB found that PI can be used as a tool for predicting hypotension. Parturient with baseline PI >3.5 are at higher risk of developing hypotension following SAB compared to those with baseline PI ≤3.5.[14] Hypotension following spinal anaesthesia was attributed to decrease in systemic vascular resistance. The reduction of systemic vascular resistance may vary in parturient depending on various factors.[19-21] This decrease in tone will correspond to higher PI values due to increase in pulsatile component due to vasodilatation. Induction of a sympathectomy by spinal anaesthesia will cause a further decrease peripheral vascular tone and increase pooling and

hypotension.

PI has been used in the study by **Mowafi et al**. to detect intravascular injection of the epinephrine-containing epidural test dose PI provided a reliable indicator of intravascular injection of epinephrine under TIVA. All patients experienced a decrease of 10% from baseline in response to direct IV injection of epinephrine, without false-positive responses after saline injection, resulting in 100% sensitivity, specificity, and positive and negative predictive values., hence its reliability to detect vasoconstriction has been demonstrated successfully.[22]

Ginosar et al. compared photo plethysmography waveform analysis with other simple bedside assessments of sympathectomy, including blood pressure changes and skin temperature Changes. Assessing PI derived from quantitative Photoplethysmography waveform analysis provides an earlier and a clearer indication of sympathetic blockade than the other clinical diagnostic modalities tested and is proven to be a reliable indicator of sympathectomy.[23].

Changes in the sympathetic nervous system by pain can impact smooth muscle tone and can alter perfusion which can be successfully measured by PI. Pain induces vasoconstriction due to sympathetic stimulation which also results in a decrease in PI. In a study by **Surekha, *et al*** it was found that the change in PI could be a surrogate monitoring tool to determine the nociception intraoperatively after excluding the confounding factors in relatively fit (ASA physical status class I and II) surgical patients.[24]. Similar results were reported in a study done by **Chun-Lin Chu et al** on 80 patients in the postoperative anaesthesia care unit HR, MAP, Visual analog scale (VAS), and PI were recorded at the baseline and post administration of IV injection of 3 mg morphine at 10, 20- and 30-minute intervals. It was observed that there was an increase in PI post administration of analgesia and a weak correlation with the VAS score. It was concluded that a 12% increase in PI can be used as a discharge criterion in postoperative

anaesthesia care units. Such an increase in PI to analgesia was observed post administration of 0.5 µg/kg IV injection of fentanyl. This was supported by a significant decrease in HR, and these changes in PI had a correlation with HR.[25].

In a study by **Mehandale et al** to predict hypotension following induction of general anaesthesia using propofol was established that a positive correlation exists between pre-anaesthetic Plethysmography variability index (PVI) and reduction in Blood pressure(BP) in healthy adults, that is, higher PVI was associated with more mean arterial pressure (MAP) reductions. Although the PPV was lower for first 5 min (68%), the NPV was higher (98%). Thus, PI is clinically very useful in predicting likelihood of no hypotension in a given set of patients. The value of PI is inversely related to the vascular tone, though not in a linear fashion. Therefore, vasodilatation reflecting higher baseline PI has been associated with reductions in BP [4]. Use of propofol among patients with high PI is likely to cause less haemodynamic disturbances than those with PI < 1.05. The mechanism of propofol-induced hypotension involves action on autonomic nervous system with effect on the sympathetic as well as parasympathetic components. There is also evidence for the direct effect of propofol through endothelium-dependent and endothelium-independent pathways. Both culminate in vasodilatation. If the patient has significant peripheral vasoconstriction that is, low PI, they are more likely to have hypotension. Similarly, if the patient is already having low vascular tone (vasodilated and relatively compensated blood volume), indicated by higher PI, there is less possibility of hypotension.[11]

In a study by **Ryu et al** concluded that at equi-anaesthetic concentration of 1.0 MAC, Desflurane produced higher PI values than did Sevoflurane, but substantially lower MAP. These findings suggest that Desflurane has greater vasodilating effects than Sevoflurane at equipotent concentrations.[6]

6.3 AIMS AND OBJECTIVES OF THE STUDY

- To compare vasodilatory properties of Desflurane and Sevoflurane using perfusion index.
- To compare systolic blood pressure, diastolic blood pressure and mean arterial pressure.

7. MATERIALS AND METHODS

7.1 SOURCE OF DATA:

A randomized controlled study will be conducted in Dayanand Medical College and hospital, Ludhiana, after approval of the Institutional ethics committee. A total of 60 patients scheduled for elective surgery under general anaesthesia will be prospectively evaluated for inclusion in this study

7.2 METHOD OF COLLECTION OF DATA:

A prospective, randomised, observational study will be conducted on ASA I and II adults. A total of 60 patients will be recruited in the study and an equal number (30 in each group) will be randomised using computer generated random numbers contained in sealed, sequentially numbered envelopes, which shall be opened by an independent anaesthesiologist. A written informed consent will be obtained from all the patients selected for study.

Inclusion criteria- sixty adults of either sex, age group (18yr-65yr) belonging to the American Society of Anaesthesiologist (ASA) Physical status I and II adults scheduled for elective surgery under GA.

Exclusion criteria- We will exclude participants using the following criteria:

1. Receiving any medications that may affect vascular tone (eg vasoactive drugs, such as calcium channel blockers or angiotensin receptor blockers)
2. Cardiovascular or peripheral vascular disease (e.g. Diabetic vasculopathy or Raynaud's disease)
3. Medications that may affect sympathetic or parasympathetic tone(e.g. beta blockers or anticholinergics)
4. Diabetes mellitus
5. Any neurological or psychiatric diseases, including history of, or treatment for, substance abuse, anxiety, or depression.

GROUP ALLOCATION: A total of 60 patients will be recruited for the study and will be allocated randomly using a computer-generated random number list to either of the two groups, using consecutively numbered opaque sealed envelopes.

1. **Group D**-Anaesthesia will be maintained using Desflurane.
2. **Group S**-Anaesthesia will be maintained using Sevoflurane.

PREANAESTHETIC CHECKUP

A thorough pre-anaesthetic check-up comprising of detailed history, (comorbidities, allergy to any drug being used) ,general physical and systemic examination will be conducted. Patients will be explained about the study being conducted and written informed consent will be taken. Relevant investigations will be sent and reviewed. All patients will be kept fasting for 8 hrs for solids, 6 hrs for semisolids and 2 hrs for clear liquids prior to surgery.

ANAESTHESIA TECHNIQUE

On arrival in the operating room, all patients will be monitored using 5 lead electrocardiography, heart rate(HR), automated non-invasive blood pressure (NIBP), pulse oximetry using Masimo® Rad-97 monitor to measure peripheral oxygen saturation (SpO2) and PI will be instituted. The Pulse oximeter probe will be positioned on index finger of the hand contralateral to the arm on which the non-invasive blood pressure cuff will be placed before induction of general anaesthesia. The mean of three consecutive readings of PI, HR, SBP, DBP and mean BP [MAP] at 1 min interval will be taken as the baseline value .

After preoxygenation with 100% oxygen for three minutes using standard face mask technique, anaesthesia will be induced using an intravenous injection of fentanyl 2µg/kg followed by1% propofol 2mg/kg titrated slowly till loss of verbal response. After administration of 0.5 mg/kg Atracurium, the lungs will be ventilated with oxygen for 3 min followed by tracheal intubation with appropriate sized endotracheal tube(ETT). ETT will be secured after ensuring bilateral air entry.

Maintenance of anaesthesia will be established with 50% Nitrous oxide in oxygen along with inhalational agent either Desflurane or Sevoflurane depending on group allocation. The anaesthetic vaporiser dial will be continuously adjusted by an anaesthesiologist to maintain a value of 1.0 MAC during the study period. The MAC values will be corrected for age based on algorithm of anaesthesia work station Dragger primus. After achieving 1.0 MAC, all parameters, that is HR, PI, SBP, DBP and MAP will be continuously recorded every minute for 20 min, after induction of anaesthesia. At any time during the study period, if the drop in SBP is >20% from baseline, it will be managed with inj. Ephedrine intravenously in increments of 6 mg. If HR is <50 bpm or a decrease by more than 30% below baseline value(whichever is lower), at any time during study period, it will be managed with inj. Atropine 0.6mg IV bolus .Under any of these circumstances, the subject will be considered a dropout, and the related data will not be included in the final analyses.

DURATION OF STUDY= 20 MINUTES

NUMBER OF CASES= 60

OUTCOME

PRIMARY OUTCOME**:** Perfusion index will be the primary outcome for the study.

SECONDARY OUTCOME: To compare heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure.

STATISTICAL ANALYSIS:

The statistical analysis will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. To determine whether the data is normally distributed, a

Kolmogorov-Smirnov test will be used. Comparison of quantitative variables between the study groups will be done using Student t-test and Mann Whitney U test for independent samples for parametric and non-parametric data respectively. For comparing categorical data, Chi square ($\chi 2$) test will be performed and fisher exact test will be used when the expected frequency is less than 5. A probability value (p value) less than 0.05 will be considered statistically significant.

Power and Sample size:

The sample size was calculated to know the PI at 95%confidence interval, with mean difference 3.3 and taking standard deviation of PI to be 2.8 based on the Study Ryu et al [1] Assuming α-error (significance) of 0.05 and power (1- ß) of 99%, the effective sample size on the basis of PI came out to be 26 in each group .This number has been increased to 30 each group to allow for a predicted dropout from treatment.

The formula used is as under:

$n = (\sigma 12 + \sigma 22) (Z\alpha + Z\beta)^2 / (m1 – m2)^2$

Where

$Z\alpha$ = Value of standard normal variate corresponding to α level of significance (1.96)

$Z\beta$ = The standard normal deviate for desired power (2.326)

m = Average

σ = Standard deviation

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

The study does not require any investigation or intervention other than those routinely done for every surgery.

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes, Attached along with.

8. LIST OF REFERENCES

1. Eger EI. New Inhaled Anesthetics. Anesthesiology 1994;80:906–22.
2. Wissing H, Kuhn I, Rietbrock S, Fuhr U. Pharmacokinetics of inhaled anaesthetics in a clinical setting: comparison of desflurane, isoflurane and sevoflurane. Br J Anaesth 2000;84:443–9.
3. Oliveira GS, Girao W, Fitzgerald PC, McCarthy RJ. The effect of sevoflurane versus desflurane on the incidence of upper respiratory morbidity in patients undergoing general anesthesia with a Laryngeal Mask Airway: A meta-analysis of randomized controlled trials. J Clin Anesth 2013;25:452–8.
4. Kazama T, Ikeda K. The comparative cardiovascular effects of sevoflurane with halothane and isoflurane. Journal of Anesthesia. 1988;2:63-8.
5. Eis S, Kramer J. Anesthesia Inhalation Agents Cardiovascular Effects. In Stat Pearls [Internet]. 2021. StatPearls Publishing.
6. Shelton CL, Sutton R, White SM. Desflurane in modern anaesthetic practice: walking on thin ice(caps)? Br J Anaesth 2020;125:852–6.
7. Lowe D, Hettrick DA, Pagel PS, Warltier DC. Influence of volatile anesthetics on left ventricular afterload in vivo. Differences between desflurane and sevoflurane. Anesthesiology 1996;85:112–20.
8. Wesselink EM, Kappen TH, Torn HM, Slooter AJC, van Klei WA. Intraoperative hypotension and the risk of postoperative adverse outcomes: a systematic review. Br J Anaesth 2018;121:706–21.
9. Hettrick DA, Pagel PS, Warltier DC. Differential effects of isoflurane and halothane on aortic input impedance quantified using a three-element Windkessel model. Anesthesiology 1995;83:361–73.
10. Cho YJ, Bae J, Kim TK, Hong DM, Seo JH, Bahk JH, et al. Microcirculation measured by vascular occlusion test during desflurane-remifentanil anesthesia is superior to that in propofol-remifentanil anesthesia in patients undergoing thoracic surgery: subgroup analysis of a prospective randomized study. J Clin Monit Comput. 2017;31:989–97.

11. Mehandale SG, Rajasekhar P. Perfusion index as a predictor of hypotension following propofol induction - A prospective observational study. Indian J Anaesth 2017;61:990.
12. Toyama S, Kakumoto M, Morioka M, Matsuoka K, Omatsu H, Tagaito Y, et al. Perfusion index derived from a pulse oximeter can predict the incidence of hypotension during spinal anaesthesia for Caesarean delivery. Br J Anaesth 2013;111:235–41.
13. Yeniocak S. Perfusion Index Analysis in Patients Presenting to the Emergency Department Due to Synthetic Cannabinoid Use. Medicina (B Aires) 2019;55.
14. Duggappa DR, Lokesh MPS, Dixit A, Paul R, Raghavendra Rao RS, Prabha P. Perfusion index as a predictor of hypotension following spinal anaesthesia in lower segment caesarean section. Indian J Anaesth 2017;61:649.
15. Wissing H, Kuhn I, Rietbrock S, Fuhr U. Pharmacokinetics of inhaled anaesthetics in a clinical setting: comparison of desflurane, isoflurane and sevoflurane. Br J Anaesth 2000;84:443–9.
16. Eis S, Kramer J. Anesthesia Inhalation Agents Cardiovascular Effects. StatPearls 2021.
17. Rödig G, Keyl G, Wiesner G, Philipp A, Hobbhahn J. Effects of sevoflurane and isoflurane on systemic vascular resistance: use of cardiopulmonary bypass as a study model. Br J Anaesth 1996;76:9-12.
18. Elshal MM, Hasanin AM, Mostafa M, Gamal RM. Plethysmographic peripheral perfusion index: could it be a new vital sign?. Frontiers in Medicine. 2021:1743.
19. Ajne G, Ahlborg G, Wolff K, Nisell H. Contribution of endogenous endothelin-1 to basal vascular tone during normal pregnancy and preeclampsia. Am J Obstet Gynecol 2005;193:234–40.
20. Barwin BN, Roddie IC. Venous distensibility during pregnancy determined by graded venous congestion. Am J Obstet Gynecol 1976;125:921–3.

21. Sakai K, Imaizumi T, Maeda H, Nagata H, Tsukimori K, Takeshita A, et al. Venous distensibility during pregnancy. Comparisons between normal pregnancy and preeclampsia. Hypertension 1994;24:461–6.
22. Mowafi HA, Ismail SA, Shafi MA, Al-Ghamdi AA. The efficacy of perfusion index as an indicator for intravascular injection of epinephrine-containing epidural test dose in propofol-anesthetized adults. Anesth Analg 2009;108:549–53.
23. Ginosar Y, Weiniger CF, Meroz Y, Kurz V, Bdolah-Abram T, Babchenko A, et al. Pulse oximeter perfusion index as an early indicator of sympathectomy after epidural anesthesia. Acta Anaesthesiol Scand 2009;53:1018–26.
24. Surekha C, Eadara VS, Satish Kumar MN. Evaluation of perfusion index as an objective tool to assess analgesia during laparoscopic surgeries under general anaesthesia. Indian J Anaesth 2022;66:260–5.
25. Chu CL, Huang YY, Chen YH, Lai LP, Yeh HM. An observational study: The utility of perfusion index as a discharge criterion for pain assessment in the postanesthesia care unit. PloS one. 2018;13:e0197630.

PROFORMA

Sr. No. MRD. No

Patient initials:

Age and Sex:

Diagnosis:

ASA Grade: Surgery proposed:

Date of Admission: Date of surgery:

Any past medical history of: Diabetes/ psychiatric illness:

Any history of use of vasoactive drugs:

History of any intermittent claudication/rest pain:

History of parathesia/burning sensation:

History of any episode of paralysis/weakness in limbs:

Preoperative Baseline Parameters:

Pulse rate:

NIBP (mm Hg):

Respiratory rate:

SPO2:

Perfusion index:

Examination:

A) Presence of any ulcer/colour change:

B) Pulselessness in any of peripheral vessels:

SIGNATURE OF CANDIDATE SIGNATURE OF SUPERVISOR

GROUPS Sevoflurane/ Desflurane	Time in minutes	Heart rate(HR)	Systolic blood pressure(SBP)	Diastolic Blood pressure(DBP)	Mean arterial pressure(MAP)	Perfusion Index(PI)
	0					
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					

SIGNATURE OF CANDIDATE SIGNATURE OF SUPERVISOR

INFORMED PATIENT CONSENT

Date: _____

I……D/o,W/o,S/o……..……a m willing to participate in the study **"A COMPARATIVE STUDY TO EVALUATE VASODILATORY EFFECT OF DESFLURANE VS SEVOFLURANE USING PERFUSION INDEX"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

…… ……

Signature of the Witness Signature of the patient

Name:

Signature of Supervisor **Signature of Candidate**

मरीज अनुमति फार्म

तिथि _____

मैं _____पत्नी/पुत्र/पुत्री _____ निवासी _____ इस शोधकार्य **"A COMPARATIVE STUDY TO EVALUATE VASODILATORY EFFECT OF DESFLURANE VS SEVOFLURANE USING PERFUSION INDEX"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____	_____
गवाह के हस्ताक्षर	रोगी के हस्ताक्षर/अंगूठे का निशान
नाम:	नाम:

_____
अन्वेषक के हस्ताक्षर

_____
विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____ **"A COMPARATIVE STUDY TO EVALUATE VASODILATORY EFFECT OF DESFLURANE VS SEVOFLURANE USING PERFUSION INDEX"** ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ